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NICOLAISEN. **Solbar gegen die Braunfleckenkrankheit der Tomaten.** [Solbar as a remedy for the brown spot disease of Tomatoes.]—*Deutsche Obst- und Gemüsebauzeit.*, lxix, 19, pp. 147–148, 1923.

The brown spot disease of tomato leaves and stems, caused by the fungus *Cladosporium fuscum* [*C. fulvum?*], was very severe in the spring of 1922 on greenhouse plants of the Lucullus variety at Calbe [Saxony]. The plants were attacked quite suddenly and had a sun-scorched appearance. Four days after the affected plants and the surrounding soil were sprayed with 2 per cent. solbar; they recovered completely, and at the end of a fortnight they were equal to their healthy neighbours in size and vigour.

S. (G. N.). **Pine branch twist. A fungus disease on Pine, Melampsora pinitorqua.**—*Cyprus Agric. Journ.*, xviii, 1, p. 19, 1923.

Young pines [*Pinus*] up to twelve years of age have frequently been known to be attacked by a fungus, *Melampsora pinitorqua*, which interferes seriously with their growth, and recently two cases have been observed in the Paphos forest (Cyprus) although many other instances probably exist. The leading shoot bends over in the shape of a hook and usually dies, and the lateral shoots which subsequently grow up to take the place of the dead leader become infected in their turn. Occasionally the leading shoot recovers, but it is safer to cut it off below the diseased part. Young trees killed by the fungus or diseased parts excised from living trees should be burnt.

The reason for the twisting of the shoots is that the attacked side does not grow at the diseased spot while the other side grows normally and so causes the twig to bend over.

TROUP (R. S.). **The Cedar fungus.**—*Report on Forestry in Kenya Colony*, pp. 25–26, 1922.

The East African cedar [*Juniperus procera*] is attacked by a wood rot fungus, *Fomes juniperinus* [sec. Lloyd *F. demidoffii*]

which also occurs on junipers in the United States. In Kenya it causes enormous losses in timber production, attacking the heartwood of standing trees. As a rule there is no external sign of attack, the presence of the disease being revealed only when the tree is cut open. Occasionally, however, the perennial ungulate fructifications may be found on the side of the tree, nearly always where a branch has been broken off. In its early stages the disease is characterized by the presence of small pockets of whitish, decaying tissue, and later by large, irregular hollows containing masses of brownish-yellow, felty mycelium. The tissues in the wood are disintegrated and permeated by the hyphae of the fungus.

To a large extent the disease may be controlled by the following preventive measures: (*a*) protection from fire and other injury; (*b*) cultivation in close crops in suitable permanent mixtures in order to effect natural pruning of the branches before they have begun to form heartwood; (*c*) periodical removal in thinnings of all stems with broken branches or wounds in which the heartwood is exposed.

CHAVASTELON. **Sur un traitement pratique et efficace des plaies des arbres.** [On a practical and efficacious treatment of the wounds of trees.]—*Comptes rendus Acad. d'Agric. de France*, ix, 17, pp. 474–476, 1923.

An efficient wound dressing, which will encourage thorough healing and at the same time preserve the exposed wood, is made as follows: hot solutions of potassium or sodium bichromate (6 per cent.) and copper sulphate (6 per cent.) are allowed to cool and then mixed. The resulting compound consists of undecomposed copper sulphate, potassium or sodium sulphate, and bichromate of copper ($Cr_2O_7.CuO.2H_2O$). The object of mixing the solutions cold is to prevent the formation of $CrO_4.Cu.2H_2O$, a reddish-brown chromate of copper which diminishes the strength of the solution.

The immediate effect of the application is a slight browning of the wood, any bichromate oxidizing and coagulating in the presence of the albuminoids and gums. The bichromate of copper, which is only slightly soluble, closes the pores and forms a durable reserve of chromic acid which is liberated by progressive dissociation, under the influence of the sap or of exterior water, of the chromate of copper into basic chromates. This weak concentration of chromic acid, while acting as a complete disinfectant, has no toxic effect on the plant and does not interfere in any way with the functions of the healing zone formed round the wound. Furthermore, the albuminoid substances of the exposed cells, coagulated and immobilized by the bichromates, contribute to the preservative action by completing the decay-proof crust formed by the chromate of copper.

Vertical and horizontal incisions on a variety of fruit trees and walnuts have been treated by the above method with complete success for the last seven years. Applied to the vine at or before the unfolding of the buds the same solution has proved highly beneficial, and also effectively controls fungous diseases, especially

[downy] mildew [*Plasmopara viticola*] and *Oidium* [*Uncinula necator*]. For the latter purpose the solution may be reduced to half the strength recommended above.

WEIR (J. R.). **The effect of broadcast burning of sale areas on the growth of cull-producing fungi.**—*Journ. of Forestry*, xxi, 2, pp. 183–184, 1923.

The most important cull-producing fungi found on stumps and slash on sale areas in Idaho and Montana after the merchantable timber is removed, and the ground burnt over, are as follows: *Poria subacida* (form), chiefly on stumps and cull butts of spruce and white pine; not fruiting. *P. weirii*, completely destroying all cull butts of western red cedar [*Thuja plicata*] and in the duff [dead leaves, broken branches, &c., accumulated in a forest] around the stumps. *Polyporus schweinitzii*, chiefly on stumps, cull butts, and in the duff of Douglas fir, larch, white pine, spruce, and in a lesser degree on other species. The fungus is more apt to reappear from infected roots at some distance from the stump than at the stump itself; the root crotches tend to hold the fire and the mycelium is destroyed. *Trametes pini* on stumps, cull logs, and large branches of white pine, larch, Douglas fir, spruce, and other species; not fruiting. *Fomes roseus* on stump cull logs of Douglas fir; not fruiting. *F. laricis* on stump cull logs and tops of larch, yellow pine [*Pinus ponderosa*], and Douglas fir; rarely fruiting from the charred ends of large cull butts. *F. pinicola* on stumps and cull logs of grand fir [*Abies grandis*] and larch; fruiting occasionally. This fungus is the least important of the group. *F. annosus* entirely destroying stump cull butts of grand fir, larch, and white pine. *Echinodontium tinctorium* on cull logs of grand fir, lowland and mountain hemlock [*Tsuga heterophylla* and *T. mertensiana* Sargent]; not observed to produce sporophores. *Armillaria mellea* on reproduction chiefly of Douglas fir, larch, and white pine, also mature trees attacking roots and débris in the duff; rarely appearing after the fire.

The majority of the cull fungi fruit with difficulty in the open exposed conditions of a clean cut area except on infected standing trees. Only when there is a large amount of slash and vegetation reproducing the moisture and shade conditions of the closed forest do sporophores appear in excessive numbers on the débris of a sale area. Such conditions may be expected to obtain in the white pine belt of Idaho. The destruction of the vegetation and the smaller kinds of slash and the charring of the stumps and logs prevents a return to the closed forest conditions.

Charred stumps and logs are rarely re-infected by the cull fungi of the living tree. Such sporophores as do appear must in most cases be produced by the living mycelium in the heartwood that did not succumb to the heat of the fire.

True saprophytes, such as *Trametes odorata*, *Lenzites saepiaria*, *Polystictus abietinus*, *Poria selecta*, *P. carbonaria*, and various species of Thelephoraceae regularly infect and destroy the inner wood of charred slash, entrance being effected through the season checks. The evidence shows that from the standpoint of a diminution of the sources of infection to standing timber broadcast burning may, in certain cases, be regarded as good silviculture.

EASTHAM (J. W.). **Sweet Potato diseases.**—*Agric. Journ. Brit. Columbia*, viii, 4, pp. 83 and 86, 1923.

The writer emphasizes the importance of preventing the introduction into British Columbia of black rot (*Sphaeronema fimbriata*) and other diseases of the sweet potato. Short of placing a total embargo on the importation of sweet potatoes, which would be a very severe handicap to trade, the only measures which can be adopted for the protection of British Columbian crops are the use of certified seed from healthy plants, the rejection of any roots showing signs of disease, and the disinfection of seed, before planting, with 1 oz. corrosive sublimate to 6¼ imperial gallons of water. Fresh soil should be used every year for the hot-bed, the woodwork being previously sterilized by swabbing with 2 lb. of copper sulphate or 3 lb. formalin to 40 galls. of water.

DIFFLOTH (P.). **Les ennemis de la Vigne. Galles et cryptogames.** [Enemies of the Vine: galls and cryptogams.]—*La Vie agric.*, xxii, 22, pp. 367–370, 4 figs., 1923.

The following fungous diseases of the vine [in France] are briefly described and appropriate measures for their control recommended: black rot, caused by *Guignardia bidwellii*; grey rot [*Botrytis cinerea*]; powdery mildew (*Uncinula necator*); anthracnose (*Sphaceloma ampelinum*); canker (*Cryptosporella viticola* and *Glomerella cingulata*). One bacterial disease (crown gall, caused by *Bacterium tumefaciens*) is also briefly noticed.

STIEGLER (A.). **Der echte Meltau (Oidium tuckeri) und der falsche Meltau (Peronospora viticola) sowie deren Bekämpfung.** [Mildew (*Oidium tuckeri*) and downy mildew (*Peronospora viticola*) and their control.]—*Allg. Weinzeit*, xl., 4, pp. 51–52, 1923.

The first application of sulphur for the prevention of mildew (*Oidium tuckeri*) [*Uncinula necator*] should be given as soon as the fruit is set and the second towards the close of the blossoming. Further applications need only be given if there is reason to fear a severe outbreak of the disease. For the control of downy mildew (*Peronospora* [*Plasmopara*] *viticola*) a 1·5 per cent. Bordeaux mixture or Bosna copper paste should be given just before, and a second spray (1·75 to 2 per cent.) immediately after, flowering. One or two more applications at 1·5 per cent. should be given if the weather conditions appear favourable for the outbreak of the disease. This treatment will also be found useful in the control of 'rotbrenner' [*Pseudopeziza tracheiphila*], which has caused much damage of recent years in the dry, stony soils of Styria [Austria].

The author particularly recommends for the spraying operations the 'Flick' apparatus, the construction and use of which is described.

HENGL (F.). **Vergleichende Versuche gegen verschiedene Rebenschädlinge.** [Comparative experiments in the control of various Vine pests.]—*Allg. Weinzeit.*, xl, 2, p. 5, 1923.

The continuation is reported of the regular annual experiments

in the control of vine pests carried out by the Vienna Plant Protection Institute and the Association of Austrian Vinegrowers. Owing to the abnormally dry weather conditions during the 1922 season, fungous pests were very little in evidence. The results of the tests may be summarized as follows: I. Experiments in the suppression of 'roter Brenner' (*Pseudopeziza tracheiphila*) on Veltliner grapes. Satisfactory results were obtained by the use of alkaline Bordeaux mixture, 'Bosna' copper paste, 'Bosna B' (copper zinc paste), and kurtakol. II. Downy mildew (*Peronospora* [*Plasmopara*] *viticola*). Good results were secured by three applications, on 6th June, 20th June, and 14th July respectively, with alkaline Bordeaux mixture, Bosna, Bosna B, Caffaro-Bosna, cuprolpasta, and kurtakol. III. Mildew (*Oidium tuckeri*). A number of wet and dry fungicides were tried against this disease but owing to the mildness of the mildew attack their efficacy could not be gauged.

RECKENDORFER (F.). **Die Rotbrennerbekämpfung.** [The control of 'rotbrenner'.]—*Allg. Weinzeit.*, xl, 4, pp. 52-53, 1923.

The 'rotbrenner' disease [caused by *Pseudopeziza tracheiphila*] has for some years past been very prevalent in all parts of Austria [see also this *Review*, ii, p. 302] where the red, red-white, and brown Veltliner vines are extensively cultivated, the red-white Veltliner variety being especially susceptible.

The fungus overwinters on the fallen leaves, where it produces ascospores in the spring. The young leaves nearest the ground are infected by the ascospores, the affected parts turning red (in black varieties) or whitish-yellow (in white varieties) and withering. In severe cases defoliation ensues and the fruit is also attacked. The development of the roots is arrested, the wood matures badly, and the fruit fails to ripen. The disease also affects the next year's growth.

Treatment with 2 per cent. Bordeaux mixture or Bosna copper paste is recommended, beginning about the middle of May.

TAYLOR (W. H.). **Vine culture under glass. Diseases and pests of the Vine.**—*New Zealand Journ. of Agric.*, xxvi, 3, pp, 172-177, 1923.

Powdery mildew (*Uncinula necator*) attacks the vine during the early stages of growth and also in the autumn. The disease can be controlled by a dusting of dry flowers of sulphur applied immediately the first symptoms appear. Should an epidemic occur during the stoning period, however, more drastic measures must be adopted. A good handful of sulphur should be mixed with sufficient milk to make a thin paste, and diluted with about 2 galls. of tepid water. All the vines and walls of the house should be syringed with the solution about an hour before the sun leaves the roof. The top ventilator should be closed during the treatment and reopened before daybreak in order to dry the vines before the sun reaches them. On the evening of the next day but one, the vines should be syringed with clean tepid water.

The germination of the spores of *U. necator* is favoured by excessive cold on tender vegetable surfaces. The sun in the early

morning, or more frequently newly admitted air, causes sudden evaporation of the moisture collected during the night, lowering the temperature and thereby producing conditions favourable to infection. Hence the ventilators should be opened early before the sun shines and care taken to avoid draughts.

Vine *Sclerotinia* (*S. fuckeliana*) occurs only in a very damp atmosphere and may be prevented by proper ventilation. The mould form of the disease can be checked by spraying with liver of sulphur at the rate of $\frac{1}{2}$ oz. per gall. of water.

Grape spot (*Gloeosporium fructigenum*) is usually restricted to thin-skinned white grapes. Spraying is not practicable and the only remedy is to increase the ventilation and prevent an accumulation of moisture during the night.

Shanking or withering of the pedicels of the berries and stems of the bunches, which results in sour and uneatable fruit, is due to an imperfect balance between the root and top. An excess of organic matter in the soil induces the formation of soft, spongy roots and a correspondingly excessive growth of soft foliage early in the season. Later the death of the spongy roots leaves the vines with insufficient roots to feed the superfluous foliage. The remedy for this trouble is to restrict the activity of the roots by rigid and timely suppression of early lateral growth. Cold and acid subsoils and very thin leaves are predisposing causes of shanking.

Scalding, due either to the direct action of the sun's rays or to sudden variations in temperature, sometimes causes serious losses during the stoning period. A frequent cause of scalding is an unduly wide range between day and night temperatures, combined with atmospheric moisture. Damping down should therefore be reduced to a minimum and a little top air left on all night, being increased in the very early morning to prevent a sudden rise of temperature. During the day the temperature should be kept as low as is consistent with proper ventilation.

Warted leaves are generally found on vines growing in rich soil in the warmer districts. The damage is done by a sudden evaporation of moisture from the gross foliage, usually caused by a current of cold air.

Aerial roots may be due to the defective action of roots in cold soil, or to a warm or moist atmosphere combined with a lack of proper ventilation due perhaps to poor drainage.

PLUNKETT (O. A.), YOUNG (P. A.), & RYAN (RUTH W.). **A systematic presentation of new genera of fungi.**—*Trans. Amer. Microscop. Soc.* xlii, 1, pp. 43–65, 1923.

The new families and genera of fungi described since Volume xxii of Saccardo's *Sylloge Fungorum* was compiled, are here assembled from all the available literature and presented in a concise, classified form with the reference accompanying each new name.

As far as is known, there has been no previous compilation of the new genera of fungi described since 1910, and its absence has necessitated a constant searching of extensive and scattered literature for any special type required. This paper will be of value to mycologists who require a survey of the systematic work carried out during the last twelve years. There are, however, many omissions.

The list of genera covers about 7,000 new species of fungi. It is an abbreviation of a catalogue entered on cards in taxonomic order, and giving the citation, classification, name of the genus, and generally the host of the fungus. Of the new species 800 belong to the Sphaerioidaceae, 700 to the Agaricaceae, 300 to the Pucciniaceae, 200 to the Dematiaceae, 200 to the Microthyriaceae, 200 to the Pleosporaceae, 150 to the Mycosphaerellaceae, and 100 to each of the following families: Dothideaceae, Hypocreaceae, Melanconiaceae, Moniliaceae, Polyporaceae, Sphaeriaceae, Thelephoraceae, Tuberculariaceae, and Valsaceae.

A bibliography of the publications consulted for the work, comprising 89 titles, is appended.

Астраханская Станция Защиты Растений от Вредителей.—Отчет за год Окт. 1921—Окт. 1922 г. [Astrakhan Plant Protection Station.—Report for the year Oct. 1921–Oct. 1922], 40 pp., 1922. [Rec'd. 1923.]

The year under review was marked by continued difficulties arising mainly from financial stress, which greatly hindered the scientific research work of the Station. The latter was, however, able to extend its activity by the creation of three branch offices and by establishing an instructor in phytopathology in each of nine districts into which the province was divided. Considerable additions were also made to the collections and library of the Station.

Most noticeable among the diseases of cultivated plants during the year were: black rot canker of apple (*Sphaeropsis malorum*), which killed a large number of trees in the best orchard districts and was also occasionally found on pear trees; apple and pear scab (*Fusicladium dendriticum*) [and *F. pirinum*], apple leaf spot (*Phyllosticta briardi*), pear leaf spot (*Septoria piricola*), cherry leaf spot (*Cercospora cerasella*), and plum leaf spot (*C. circumscissa*), peach leaf curl (*Exoascus deformans*), plum 'scorch' (*Polystigma rubra*), and pear rust (*Gymnosporangium sabinae*). Corn crops suffered heavily, especially in irrigated fields, from various kinds of smut and rust. A new functional disease, strongly resembling mosaic, appeared on potatoes, greatly reducing the crops, and attacking also, but more rarely, tomatoes and eggplants (*Solanum melongena*) which perished in a few days. In some cases a rotting of potato tubers was observed in the soil, but the cause has not yet been determined. Vegetable marrows were heavily attacked by the semi-saprophyte *Sporidesmium mucosum* var. *pluriseptatum*. The station recorded for the first time the appearance of *Oidium tuckeri* on the vine in some districts, which caused very appreciable losses.

Borg (P.). **Report of the Plant Pathologist 1921–1922.**—*Malta Govt. Gaz. Suppt.* xxi, pp. 278–280, 1923.

Potato blight (*Phytophthora infestans*) appeared early in November on the winter crop of potatoes and caused a heavy reduction in the yield, the weather being very favourable for its development. The first outbreaks on the spring crop were also

rather virulent, but a serious epidemic was averted by extensive spraying and also by the continuation of dry weather.

Owing to the protracted spell of hot, dry weather in March [1922] downy mildew of the vine [*Plasmopara viticola*] did not develop to any great extent, but spraying with normal Bordeaux mixture was carried out on a large scale as a precautionary measure. The treatment of *Oidium* [*Uncinula necator*] has now become a matter of routine in most vineyards. The disease known as 'roncet', the etiology of which is obscure, appeared on many vines of the Rupestris du Lot variety in the American vine nurseries at Gozo and elsewhere. The only known remedy is the removal of infected plants before the second year after the appearance of the disease.

Departmental Activities: Botany.—*Journ. Dept. Agric. S. Africa*, vi, 5, p. 381, 1923.

Leptothyrium pomi, the cause of 'sooty blotch' and 'fly speck' in apples, has been identified on apples from the Transkei and Natal, this being its first recorded appearance in South Africa. Whilst the injury does not penetrate very far, the unsightly appearance of affected fruit impairs its market value, and badly diseased apples often look shrivelled or wizened. The dark coloured blotches on the surface of the fruit are irregular in outline but tending to be circular, and they may be so numerous that the fruit appears as if covered with soot. 'Fly speck' is another aspect of the same disease. In this case groups of six to one hundred black, shiny dots, which appear on the surface of the apple, recall fly-blown specks, hence the name. Damp situations and abundant rain in the summer favour the development of the fungus, which can be controlled by several applications of a lime-sulphur spray, as in the treatment for apple scab.

'Vrotpootje' of wheat is still being studied by the Department. Particulars obtained from diverse sources would seem to indicate that more than one disease is known by this name. Thus, a case from the Koeberg District has been diagnosed as a foot rot, due probably to a species of *Fusarium*, while from another region the disease resembles the 'take-all' and 'whitehead' disease (*Ophiobolus cariceti*) known in Europe and other parts of the world.

DICKSON (J. G.). **Influence of soil temperature and moisture on the development of the seedling-blight of Wheat and Corn caused by Gibberella saubinetii.**—*Journ. Agric. Res.*, xxiii, 11, pp. 837–869, 6 pl. (2 col.), 15 graphs, 1923.

Gibberella saubinetii may attack wheat and maize seedlings in varying degrees of intensity, resulting (*a*) in blight before emerging from the soil, with a consequent reduction in stand; (*b*) in a yellowing and wilting of the seedling after it emerges; and (*c*) in a stunting of the seedling owing to the enfeeblement of the root system. In both wheat and maize the invaded tissues turn reddish-brown to carmine red, according to environmental conditions. The chief difference between the symptoms of the disease on the two hosts is the more definite character of the lesions on the larger

stems and roots of maize. In both plants the period of severe infection is usually restricted to the seedling stage. Seedling blight develops from two chief sources: scabbed or infected seed and infested soil. The mycelium of the fungus hibernates in or on the scabbed kernels of wheat, many of which show no marked external symptom of disease before sowing, and also in the seed of maize. The organism develops as a saprophyte on decaying crop refuse near the surface of the soil and assumes a parasitic character only when the seedlings are weakened by unfavourable conditions.

The results of pure culture experiments, the technique of which is fully described, showed that the parasite functions normally over a fairly wide range of temperature, namely, from 3° to 32° C. The optimum temperature for spore germination, vegetative development, and sporulation was found to be about 24° on unacidified and 28° on acidified media.

It was further shown by comparative experiments in the development of wheat and maize at different soil temperatures that the former is favoured at all stages of growth by a low temperature (16° to 20° C. for spring wheat and 12° to 16° for winter varieties), and the latter by a high one (24° to 28° C.).

The temperature of the soil is undoubtedly the most important single factor determining the extent of seedling blight. The most favourable soil temperature for the infection of wheat was found to range from 12° to 28° C., while the corresponding figures for maize infection were 8° to 20° C.

It was also shown that low soil moistures favour the infection of wheat seedlings at all temperatures, and at low temperatures may be the factor determining infection. Thus at 8° C. soil temperature, 72 per cent. of the seedlings grown in soils at 30 per cent. of their moisture-holding capacity were blighted, and 44 per cent. of those grown at 45 per cent. moisture, whereas at 60 per cent. soil moisture no blight occurred.

In order to check the results obtained under greenhouse conditions of the effect of temperature and moisture on infection, a series of periodic field sowings were made at Wisconsin during the spring and autumn of 1920 and the spring of 1921. It was thought that such trials might point towards possible remedial measures against this and similar diseases. The results under field conditions corresponded with those obtained in greenhouse tests. Sowing when the soil is cool, that is, spring wheat at the earliest safe date in the spring and winter wheat at the latest safe date in the autumn, reduces seedling blight [see this *Review*, i, p. 168].

Maize, on the other hand, should be sown when the soil is warm, at the latest safe date in the spring. The critical soil temperature for the seedling blight of wheat is about 12° C. as determined both in constant soil temperature tanks and in the field, where the temperature was estimated by the mean daily field soil temperature, the corresponding figure for maize being 20° to 24° under both greenhouse and field conditions. Mean soil temperatures for periods of considerable duration are more influential as factors in the production of seedling blight and similar diseases than brief extremes of soil temperature. The influence of environmental factors on the hosts appears to be the fundamental cause of

susceptibility to the disease, the seedlings becoming susceptible when they are unable to respond favourably to the environment.

A bibliography of 34 titles is appended.

DREGER (C.). **Praktische Erfahrungen eines Züchters mit der Bekämpfung von Pflanzenkrankheiten.** [The practical experiences of a breeder in the control of plant diseases.]—*Weiner landw. Zeit.*, lxxiii, 25–26, pp. 102–104, 1923.

After many years' experience in the cultivation of cereals, the writer recommends the control of diseases by selection only when the disease cannot be more speedily and effectually combated by mechanical or chemical treatment. Yellow rust of wheat (*Puccinia glumarum*) has not yet been adequately controlled by mechanical or chemical means, and the same applies to brown rust of wheat and rye (*Puccinia triticina* and *P. dispersa*) and to barley leaf spot (*Helminthosporium teres*). With the exception of the first-named, however, these diseases do not cause sufficient damage [in Austria] to justify any great expenditure of time and labour on plans for their control.

The hot water treatment of loose smuts of wheat (*Ustilago* [*tritici*]), barley (*U.* [*nuda*]), and oats (*U.* [*avenae*]) is described at length. As regards loose smut of barley, the seed may safely be heated to a temperature of 53° to 53·5° C. for ten minutes after a preliminary soaking of eight hours at a normal temperature, without any risk of reduced germination. It has frequently been stated that the thick-eared or 'erectum' varieties of barley are immune from loose smut, but the writer has not found this to be the case. For the control of loose smut of wheat the seed should be heated to a temperature of 52° for ten minutes (54° for summer wheats). Both for barley and wheat the eight hours' presoaking is essential to the success of the treatment. Wheat is considerably more difficult to treat than barley, owing to the variations in the time of treatment required.

In the case of loose smut of oats no preliminary soaking is required, as the fungus is outside the seed. The writer has secured excellent results for many years by a preliminary heating at 45° followed by hot water treatment for ten minutes at 56°. Stripe disease of barley (*Helminthosporium gramineum*), the incidence of which has greatly increased of recent years, was completely controlled by immersion of the seed in 375 gm. of uspulun per hl. of water for one hour. The seed had previously been treated with hot water, but this process alone does not give adequate control.

Bunt of wheat (*Tilletia tritici*) cannot be effectively controlled by the hot water treatment. The writer tested a number of fungicides and obtained the best results by immersion of the seed in 500 gm. 40 per cent. formaldehyde per hl. of water for fifteen minutes. It is essential that the spore balls should be removed by a preliminary immersion in water. The writer has observed that animals are frequently fed on smutted grain, with the result that the infection is perpetuated in manure. The organism is evidently capable of leading a saprophytic existence in the soil for at least two years, since wheat sown by the writer was found to be heavily infected,

in spite of treatment with formalin, presumably by the spores of smutted wheat grown in the same field for experimental purposes two years earlier.

TOWER (W. V.). **Citrus scab.**—*Porto Rico Agric. Exper. Stat. Agric. Exten. Note* 53. [Reprinted in *Trop. Agric.*, lx, 4, pp. 224–226, 1923].

Scab [see this *Review*, ii, p. 364] is the most severe disease of citrus in Porto Rico. During the early years of the industry only young trees were attacked, but at present many valuable old trees are producing inferior fruit as a result of the disease.

The results of the first season's co-operative spraying experiments on a large estate are very encouraging. The weather was exceptionally wet and the blooming period much prolonged. Four applications of Bordeaux oil [see this *Review*, ii, pp. 363, 364] were given to 3,000 trees on 29th December, 27th January, 13th February, and 9th March respectively. The results were as follows: clean fruit 94·4 per cent.; trace of scab 5·2 per cent.; slightly scabby 0·4 per cent. Check trees in one of the worst infected groves showed only 10 per cent. clean fruit. Sprayed trees in this grove showed 90·6 per cent. clean fruit. Another grove was divided into three sections, one part was sprayed four times, another twice, and the third left as control. The percentages of clean fruit were 91·2, 83·9, and 24·5. Results similar to the above were obtained in other groves.

The author issues a warning with regard to scale insects, however, as the beneficial fungi will be killed and spraying against scale insects may be counted upon as necessary.

Recent tests with oil emulsion have been made at the Experiment Station on grapefruit trees with fruit six months old, the solution being used at 1·5, 2, 2·5, and 3 per cent. strengths. There was no defoliation or injury to the fruit. In all the tests with 3–4–50 Bordeaux plus 0·5 per cent. of oil there was a slight burning of the young shoots but no injury to open blossoms or small fruit.

Details regarding convenient arrangements for carrying out the spraying are added.

FAWCETT (H. S.). **Gummosis of Citrus.**—*Journ. Agric. Res.*, xxiv, 3, pp. 191–232, 8 pl., 1923.

Pythiacystis gummosis, which first attracted attention in the Azores in 1834 and subsequently spread to most other citrus-growing countries, is the most widespread and destructive of citrus gum diseases in California. On the highly susceptible common lemon (*Citrus limonia*) the disease is characterized by copious exudations of gum and large dead areas of bark on the trunk and main roots, followed by yellowing and dropping of leaves. On sweet orange (*C. sinensis*) and other semi-resistant forms the dead patches are smaller. The gum may arise not only from the margin of the infected area but also from a large contiguous, outer, non-invaded zone. In the invaded area of the bark the tissues are coloured mineral brown to burnt umber or fawn, and the same discolorations are found usually extending about 2 to 5 mm. into the outer layers of the wood. In the outer gummous zone the cambium

is chamois to yellow-ochre in colour. Gum pockets, 2·5 to 5 cm. in longest axis, are frequently formed, the clear, watery gum hardening as it comes to the surface and turning chestnut-coloured. It has been shown by experiments that the disease is readily transmissible to healthy trees by inoculation with fragments of bark tissue cut from the advancing margins of destroyed regions, but not by tissue from the outer gummous zones or by old dead tissue. Cultural tests demonstrated that live mycelium of *P. citrophthora*, the causal organism of lemon brown rot, was present in the narrow band or fringe at the advancing edges of the invaded zone. Elsewhere the mycelium was absent or dead. Numerous inoculation experiments with pure cultures of the fungus on healthy trees under various conditions resulted in the reproduction of the typical symptoms of the disease. *P. citrophthora* was re-isolated from many bark lesions in which it had been present from one to eleven months. Lemon fruits affected by *Pythiacystis* brown rot were shown to be capable of inducing the same type of gummosis as that caused by the fungus from gummosis lesions. The inoculation of branches and large roots produced less severe infection than that of the trunk.

A species of *Fusarium* is commonly found to be associated with *Pythiacystis* gummosis, and the results of a few tests indicated that it aggravates the severity of the disease but is incapable of initiating it.

Observations and experiments both showed the following decreasing order of resistance to *P. citrophthora*: sour orange (*Poncirus trifoliata*), rough lemon (a resistant variety of *C. limonia*), pomelo (*C. grandis*), sweet orange, and common lemon. The inoculation of small roots of young trees indicated that common lemon roots are somewhat susceptible and those of sour and sweet orange and pomelo resistant.

'Mal di gomma', due to *Phytophthora terrestris*, was shown to be similar to the damage caused by *P. citrophthora* at the junction of the main roots and trunk of old orange trees in California. Inoculations with both these fungi, under identical conditions, produced similar lesions.

Experiments showed that the disease may be largely prevented by the application of Bordeaux mixture or paste to the trunks and arrested in its progress by the excision of the affected bark and treatment with a suitable fungicide. The outer gummous zone eventually recovers and need not be removed.

Botrytis gummosis causes a softening of the invaded bark in the early stages and on this area are produced conidiophores and conidia in damp, cool weather. In the later stages the outer layer of bark is killed and hardens long before the inner layer. As in *Pythiacystis* gummosis, there is a non-infected, outer gummous zone. There is a stronger tendency towards the removal of the bark under the dead layer than in *Pythiacystis* gummosis, and the flow of gum is less copious. In California the *Botrytis* gummosis is almost exclusively confined to trees over ten years of age growing in the coastal regions and it is much more dependent than *P. citrophthora* on wounds or other predisposing conditions. A strain of *B. cinerea* has been isolated from numerous lesions on trees affected

by gummosis, and the inoculation of healthy lemon trees with fragments of the diseased bark and pure cultures of the fungus resulted in typical symptoms of the disease. Attempts made to induce gum formation by various kinds of wounds on lemon tree trunks gave negative results when the wounds were kept free from contamination by injurious organisms or chemicals. The disease may be effectively controlled by cutting or scraping away the dead bark, leaving intact the live inner layer next to the cambium, and painting the treated area with Bordeaux paste or one of the coal-tar products containing only the heavier oils.

Sclerotinia libertiana is occasionally found associated with rapid drying of the bark on the roots and trunks of citrus trees growing in damp, cool situations, especially after severe frosts. At first there is a plentiful flow of gum and the bark is soft, but subsequently the latter dries into long shreds and usually contains flat, black sclerotia. Though the fungus normally advances more rapidly than *Botrytis*, it is soon arrested and callus begins to form when the gum accumulates. The results of inoculation experiments with pure cultures showed that the fungus is able to produce the typical symptoms of the disease on healthy lemon tree trunks.

A number of other organisms, besides the *Fusarium* referred to above, commonly found on the dead or decaying bark of citrus trees were used in inoculation experiments on lemon and orange trees to ascertain their relation, if any, to gummosis. A slight amount of gum exudation from cuts was produced by *Penicillium roseum*, *Diplodia* sp., *Coryneum beijerinckii*, *Coprinus atramentarius*, *Alternaria* sp., and *Hypholoma* sp. No definite pathological symptoms, however, were produced. Negative results followed inoculation with *Cladosporium* sp., *Rhizopus* sp., *Spegazzinia ornata*, *Penicillium digitatum*, and *Pseudomonas cerasi*.

Gum in citrus is similar to cherry gum and gum arabic, and appears to originate mainly in the xylem tissues by hydrolysis of the cellulose walls. Mechanical injuries, continuous pressure on the bark, and obstructions in the sap current by the insertion of glass or wooden plugs and the like are incapable of causing gum formation in citrus trees when the tissues are healthy and not irritated by such chemical stimuli as hydrocyanic acid, spray mixtures containing copper sulphate not properly neutralized with lime, or ant poison containing arsenic. Injuries by certain insects, e.g. *Tortrix citrana* and grasshoppers, sometimes cause slight gum formation, probably due to secretions by the insects or to contamination.

Observations and experiments indicate that burning, freezing, and partial desiccation are not in themselves important factors in gum formation in citrus but merely aid the wood-rotting organisms which later induce gummosis.

Certain chemical substances, chiefly acids, alkalis, and salts of heavy metals (especially the last-named), can induce gum formation when injected into citrus bark. In no case was it possible, however, to reproduce all the symptoms of any of the gum diseases by such injections.

The results of comparative experiments with filtrates from diseased and healthy tissue show that the former contain a substance capable of passing through a fine clay filter and inducing

gum formation. This was destroyed by boiling, indicating the presence of a heat-sensitive enzyme in the filtrate from diseased tissue.

A bibliography of 65 titles is appended.

FAWCETT (H. S.). **Gum diseases of Citrus trees in California.**—*California Agric. Exper. Stat. Bull.* 360, pp. 370–423, 15 figs., 1923.

In this paper the available data on various types of citrus gummosis are presented, with special reference to the incidence of the diseases under California conditions. A full scientific description of the *Pythiacystis*, *Botrytis*, mal di gomma, *Sclerotinia*, and other milder forms of gummosis has been published elsewhere [see preceding abstract].

In California the type of gummosis induced by *Pythiacystis citrophthora* is most prevalent on damp, heavy soils in the coastal districts and occurs chiefly on lemon trees budded low on sweet orange stocks. Temperature also plays an important part in the development of the disease, which would explain the slow progress of the disease during dry, hot periods and in the valleys of the interior. Deep planting or the accumulation of soil next to the stems also assists in the development of the disease. Full directions are given for the control of *Pythiacystis* gummosis by various methods, according to the age and condition of the trees and other factors. Among other forms of treatment may be mentioned spraying with Bordeaux mixture; cutting out infected tissues and painting the wound with Bordeaux paste, benzine-asphalt, or other suitable mixture; cutting back the tops of severely affected trees; and bridge grafting or inarching in certain cases.

Phytophthora terrestris, the causal organism of mal di gomma, has only once been isolated from an orange tree in California, viz. in 1912, though the same or a closely allied species appears to be very prevalent in Florida, Cuba, the Argentine, Jamaica, and India. In Florida it causes a severe type of gummosis known as foot rot. A certain form of this disease so closely resembles the *Pythiacystis* gummosis as to be distinguishable only by careful laboratory examination, and the control methods in both cases are practically identical. The temperature relations of the two fungi are somewhat different [see this *Review*, i, p. 312], the optimum for *Phytophthora terrestris* being about 30° C.

Botrytis cinerea and *Sclerotinia libertiana* each causes a form of gummosis [the symptoms of which are described in the preceding abstract]. The control methods are essentially the same as those recommended in the case of *Pythiacystis* and mal di gomma.

Psorosis or scaly bark, the most conspicuous feature of which is the occurrence on the trunk and large branches of irregular scales of bark, $\frac{1}{4}$ to 1 inch in diameter, develops extremely slowly and it has not yet been possible to ascertain the cause of the disease. It is believed, however, that a parasitic organism is involved. The disease is usually most active in the summer and early autumn when it is accompanied by gum formation and exudation, the gum appearing to arrest rather than promote the advance of the disease.

Control measures for psorosis vary with the different stages of the disease. At the beginning only an outer layer of bark appears to be injured and the affected bark may be scraped rather deeply and the surrounding bark very lightly for four to six inches in all directions beyond the margin of the diseased areas. When, however, the latter have extended so as to cover about one-third of the circumference of the trunk, they should be scraped and disinfected and the process repeated again six months or a year later. When the disease has been present five, ten, or more years, there is little hope of a permanent recovery, but such trees frequently remain productive for a considerable time, and in cases of only moderate severity the progress of the disease may be checked by drastic pruning and the application of benzine-asphalt or some other covering to the bark after excising the decayed areas. The results of experiments indicate that the best time for treatment is during the late spring and summer months. Mercuric cyanide (1 part in 500 of water) and alcohol (500 parts) is an excellent disinfectant.

Diplodia gumming occurs frequently in California, especially San Diego, in connexion with the 'heart rot' following severe frosts. It may be prevented to some extent by treatment with a suitable non-air-tight disinfectant, and by whitewashing all the pruned parts of the tree to avoid sunburning.

Twig gumming, due to an unknown cause, occurs in California and Arizona. It is characterized by the sudden wilting of leaves and dying back of twigs to a distance of one to two feet from their tips. At the base of the dead portion the bark splits and gum is plentifully exuded. The disease often occurs after periods of drought, and treatment on the lines described under *Diplodia* gumming is recommended.

Exanthema or die-back, of only secondary importance in California, is believed to be due to nutritional disturbances and is characterized by dark excrescences and multiple buds on the branches, the dying back of terminal branches, compact, shortened growth, and dark irregular reddish-brown patches on the surface of the fruit. Clear gum exudes from the pockets on the twigs or is found internally near the centre of the fruit at the angles of the segments. The use of nitrogenous fertilizers, which are considered to aggravate the disease in Florida, has not proved injurious under California conditions.

Minor forms of gumming associated with *Penicillium roseum*, a species of *Fusarium* [see preceding abstract], *Alternaria citri*, *Bacterium citriputeale*, and various fungi, as well as with insect injuries and chemical stimuli, may generally be controlled by the methods outlined above.

GADD (C. H.). **A possible physiological cause of 'nut-fall' of Coco-nuts.**—*Trop. Agric.*, lx, 2, pp. 112–114, 1923.

The fall of immature coco-nuts in Ceylon cannot always be attributed to the attacks of *Phytophthora* since it frequently occurs in the absence of any pathogenic organism. Comparison with the fall of young fruits after a period of drought in the case of citrus and other plants suggests that a similar cause may be responsible

for the nut fall of the coco-nuts. The latter, however, takes place in Ceylon principally on the heavy loam of the Kurunegala district during the rains of the north-east monsoon, which tend to produce a water-logging of the soil and thus interfere with the absorption of water and the aeration of the root system. The author suggests that these adverse conditions may result in premature dropping of the fruits.

ARMSTEAD (DOROTHY) & HARLAND (S. C.). **The destructive effect of micro-organisms on raw Cotton and Cotton fabrics: a summary of the literature.**—*Journ. Textile Inst.*, xiv, 6, pp. T 157–T 160, 1923.

Cotton, both in the raw and when manufactured, is subject to fungous attack, which results in 'tendering', due chiefly to bacterial action, or in discolorations with or without pronounced 'tendering'. The various fungi are known collectively to the industry as 'mildew'. The size employed in yarns and fabrics provides an excellent medium for the growth of many fungi, and generally an antiseptic is added in order to prevent such growth.

The authors divide the literature on the subject under the heads: bacteria and fungi. Amongst papers dealing with the former, brief extracts are given of four, which particularly interest the cotton industry, and of those relating to fungi ten are shortly summarized. A list of references terminates the paper.

RITZEMA BOS (J.). **Eene nieuwe ziekte van de Zonnebloem.** [A new disease of the Sunflower.]—*Tijdschr. over Plantenziekten*, xxix, 7, p. 128, 1923.

Referring to a disease of sunflower plants in Montana believed to be caused by *Sclerotinia libertiana* (*Phytopath.*, xi, 1, p. 59, 1921), the writer states that the stalks of sunflowers in his garden at Amsterdam were also attacked by the same fungus. The roots, however, were not affected, as in the Montana specimens. Large sclerotia were formed in the interior of the stalks and the whole plant withered above the point of attack. The flowers were growing in a very shady position.

KILLIAN (C.). **Le Polythrincium trifolii Kunze parasite du Trèfle.** [*Polythrincium trifolii* Kunze parasite on Clover.]—*Rev. Path. Vég. et Ent. Agric.*, x, 3, pp. 202–219, 14 figs., 1923.

Trifolium repens is frequently attacked by the fungus *Polythrincium trifolii* Kunze [in France]. The symptoms appear at the end of June as granular black spots on the under side of the leaves and limited by the veins. Their number and diameter vary considerably. When large (at most 1 mm.) the spots are at first few in number, though eventually the whole under surface will be covered. Sometimes they are localized either at the base or on the margins of the leaflets, and this may be explained by the fact that the rain drops carrying the spores tend to accumulate in the lower part of the leaflets, when these take on an erect position at night. Infection in the spring can take place from May onwards. Its initial localization makes it not easy of discovery, but later the disease progresses more rapidly, reaching

a climax at the beginning of autumn. Frosts completely arrest further growth, and from January onwards the disease seems to disappear altogether, though plants kept under glass during that period will continue to show the spots.

On *Trifolium repens* the disease is usually benign, and in one case only has *T. pratense* been found attacked. *T. incarnatum*, however, is very susceptible and whole fields of it may be entirely destroyed; conditions which make for vigorous growth in this host also apparently produce increased virulence in the fungus.

The experiments made with *T. repens* have demonstrated that infection by *P. trifolii* is dependent on various circumstances which are difficult to distinguish. Speaking generally, natural conditions favour the success of the inoculations. Under moist conditions in the greenhouse the period of incubation appears to be from four to six weeks, while it may be even longer if the plants are kept in a dry atmosphere. In the field, however, the state of the atmosphere appears to have no influence on the incubation period, which under these conditions only lasts six to nine days, although it greatly affects subsequent growth. In dry weather the spots increase little, or not at all, but growth is normal in damp conditions. Infected leaves disintegrate much more rapidly than healthy ones, and this process is the more intense the more virulent the attack. After some weeks not a trace remains of the fallen and dried leaves, the very minute débris being washed into the soil, and the perithecia are thus enabled to survive for comparatively long periods and re-infect the new crop; a case is cited where the fungus persisted in the soil for five years. Control is very difficult if not impossible, and the only means of checking the inordinate spread of the disease would appear to be to delay the date of sowing.

Pure cultures of the fungus could not be obtained, as although the conidia germinated, the mycelium soon died since *P. trifolii* is an obligate parasite. On the living leaves of clover the relatively short germ-tubes penetrate the epidermis at the radial walls and the mycelium then invades the underlying cells, progressing rapidly in the intercellular spaces rather than in the palisade tissue. In young leaves the mycelium penetrates later on into the cells themselves, but this is not usually the case in older leaves. When inside the cells, the elements of the host and those of the parasite are scarcely distinguishable, recalling an advanced parasitism such as occurs in the rusts, and also, according to the author, in the Ascomycete, *Cryptomyces pteridis*.

After being established in the leaf, *P. trifolii* begins rapidly to form its reproductive organs. The hyphae, isolated at first, become massed together near the epidermis, forming a plectenchymatous cushion which increases in size and finally breaks through the epidermis. The peripheral cells of the plectenchyma then grow out into irregular lobes, in which all the protoplasm and the nuclei from the old cells concentrate. On these lobes arise the conidiophores, which are of a peculiar structure, from which the fungus derives its name. Instead of growing straight they develop spirally, in the form of a screw. The conidia borne on their free ends are two-celled, the larger cell containing a denser protoplasm and

a greater number of nuclei than the other, which is attached to the conidiophore by a thick papilla, where at the least contact the conidium becomes detached. Conidia are formed abundantly until December, when their production gradually stops and is replaced by the pycnospores which develop in pycnidia. The latter have their beginning in the interior of the green leaf near the stomata, through which the pycnospores are evacuated as fast as they are formed. Towards the middle of December the pycnospores become less abundant and their production ceases in January. Their place is taken by the perithecia which carry the fungus over the winter. These bodies are formed inside the green leaf simultaneously with the pycnidia. Washed into the soil with the débris of fallen leaves, they mature with the approach of spring. The apical portion of the body then lengthens into a beak, perforated by a narrow channel provided with periphyses. The 2 to 4 large, fusiform asci contain 8 hyaline, two-celled, elongated and slightly curved spores, measuring 26 by 6 μ. These asci are accompanied by some proasci, which will take their place in due course. The covering of the beak becomes much distended and ruptured in places, and its disintegration eventually renders the ejection of the ascospores possible. The latter start the infection in the spring, as the author was able to demonstrate by actual inoculations.

The ascigerous stage of *P. trifolii* was named by Saccardo *Phyllachora trifolii*, but the author, who examined ample living material, states that the ascospores are always bi-cellular and that this forbids the classification of the fungus under the genus *Phyllachora*. He thinks that the choice can only lie amongst the Hyalodidymae in the third section of the Dothideales, *Plowrightia* being the genus selected, and that *Phyllachora trifolii* must therefore be replaced by *Plowrightia trifolii*.

STEWART (F. C.). **Fruit disease problems of to-day.**—*Proc. New York State Hort. Soc. 1922*, pp. 61–69, 1923.

The following diseases are briefly discussed with special reference to the present position of research on each. Raspberry mosaic; fireblight [*Bacillus amylovorus*]; bitter rot or anthracnose of apples [*Glomerella cingulata*], destructive attacks of which occurred during 1922 in Ulster and Orange Counties (New York) and on Long Island; crown gall [*Bacterium tumefaciens*]; and cedar rust of apples [*Gymnosporangium juniperi-virginianae*], which is extremely prevalent in the Hudson Valley.

The problems of peach leaf curl [*Exoascus deformans*] and cherry leaf spot [*Coccomyces hiemalis*] may be regarded as solved by the timely application of appropriate sprays.

DAY (L. H.). **Control of Pear blight in California.**—*Amer. Fruit Grower*, xliii, 6, pp. 3 & 12, 3 figs., 1923.

In 1921 and 1922 the writer carried out experiments on Bartlett pears to test the scarification method for the control of pear blight [*Bacillus amylovorus*].

It was found that the scarifying operation had to be continued for some distance beyond the confines of the visible signs of the

disease and not the minutest particle of outer bark left on the shaved area. The addition of glycerine [amount not stated] to Reimer's combination of cyanide of mercury and bichloride of mercury (1 part of each to 500 parts of water) [see this *Review*, ii, p. 274] greatly reduced the incidence of infection. Full directions are given for the scarification treatment.

Experiments were also carried out with numerous disinfectants to ascertain whether the disease could be controlled without resorting to surgical measures. Some success was obtained by painting with cresylic acid, silver nitrate in nitric acid, nitric acid, zinc chloride, zinc nitrate, iodine, and iodine salts. Zinc chloride was the most promising of these substances, 98 per cent. of the treated cankers on trees under eight years old being arrested by its action.

WORMALD (H.). **Blossom wilt of Plum trees.**—*Journ. Min. Agric.*, xxx, 4, pp. 360–363, 3 figs., 1923.

Blossom wilt of plum trees, caused by *Sclerotinia* (*Monilia*) *cinerea* forma *pruni* is responsible for considerable damage in England in certain seasons, the branches as well as the flowering spurs being killed back. Serious outbreaks of this disease have been traced not only to mummified fruits remaining on the trees during the winter, but also to cankers, dead twigs, and spurs, as is also the case in the corresponding blossom wilt of apple trees [*S. cinerea* forma *mali*] (*Journ. Min. Agric.*, xxiv, 5, p. 504, 1917).

In May 1923 the writer examined some Giant Prune plum trees, many young branches of which were killed back from the tip for a distance of six inches to over a foot. At the lower end of every dead portion there was a flowering spur with brown, withered flowers which usually bore green tufts consisting of the spore chains of the fungus. Further examination revealed the presence of a few dead twigs killed by the fungus in the previous year. These had produced spore pustules during the winter and the resulting spores served to infect the opening flowers. The wilt was most severe in the vicinity of such twigs. No mummified fruits had been left on the trees. The Czar and Purple Egg varieties growing in the same plantation were scarcely affected.

The blossom wilt also infects the leaves and shoots, giving rise to the 'wither tip' condition (*Ann. Appl. Bot.*, v, 1, p. 28, 1918) and to 'shoot wilt' (*Ann. Bot.*, xxxvi, 143, p. 305, 1922). Subsequently the fruit may also become infected.

All dead wood should therefore be removed as early as possible and the trees sprayed in the late winter with a solution containing 1 per cent. soft soap and 1 per cent. caustic soda. The disease is liable to spread from plums to sweet cherries where the above precautions are neglected.

DICKSON (B. T.). **Raspberry mosaic and curl.** *Scient. Agric.*, iii, 9, pp. 308–310, 1923.

After briefly summarizing the literature on virus diseases of raspberry, the author describes the symptoms, varietal susceptibility, and spread of mosaic and leaf curl of this host [see this *Review*, i, p. 218, and ii, p. 17].

The symptoms of mosaic vary with the time of infection and the

weather. Canes newly infected in spring and early summer develop new leaves which usually show many dark green blisters in marked contrast to the pale yellow remainder. The petioles are slender, the leaflets rather spindly, and if the dark green areas are near the midribs the margins are rolled down and in. Under dry weather conditions the later leaves are speckled and have somewhat shorter petioles and broader leaflets. Late infections also usually produce the speckled condition, although in the following spring the blistering and distortion of the leaflets occur. As a rule the cane is somewhat dwarfed and spindly. In fruiting canes diseased laterals are liable to be spindly and weak. There is a distinct tendency for infected plants to flower earlier than normal, and the fruit becomes more and more tasteless, with also a reduction in pulp. Once a plant is infected it never recovers, and diseased plants should therefore be removed. Of the varieties commonly grown none is resistant, but St. Regis and Sunbeam seem least susceptible. The agent in the spread of the disease is probably *Aphis rubiphila*; pruning does not appear itself to be an important factor.

Leaf curl is also a systemic disease from which the plants never recover. The leaf symptoms are the dwarfing of the petioles, the arching and ruckling of intervenal areas, and the dark green or quite yellow colour of the leaves. Severely infected leaves are reduced in size, the leaflets sometimes measuring only half an inch. The canes are dwarfed but are thick and stocky. The fruiting laterals are short, have an upright tendency, and bear curled, compact, dark green, small leaves. They flower late and the fruit is small, bitter, and often with no pulp. Columbia and Newman 1, 23, and 24 varieties are resistant. *Aphis rubiphila*, as shown by Rankin, is undoubtedly the infecting agent in leaf curl.

Control measures for both diseases consist in thorough roguing and burning the diseased plants. Early eradication appears to be commercially successful, and when plantations are badly infected they should be scrapped and new ground planted with disease-free stock. Tests regarding insect control are necessary before recommendations on this point can be made.

Hvorledes skal man bekjaempe stikkelsbaerdraeperen? [How is the control of Gooseberry mildew to be accomplished?]—*Norsk Havetid.*, xxxix, 7, pp. 114–115, 1923.

The following results were obtained in a series of spraying experiments against gooseberry mildew [*Sphaerotheca mors-uvae*], carried out in two different districts of Norway on over 250 gooseberry bushes with (1) coarse Spanish common salt; (2) formalin; (3) lime-sulphur 20° Baumé; and (4) solbar. The disinfectants were applied on 8th May (winter spray), and twice in the latter half of June (summer spray) in the following strengths: salt 4 kg. per 100 l. (winter) and 2 kg. per 100 l. (summer); formalin 1 in 40 (winter) and 1 in 100 (summer); lime-sulphur 1 in 4·75 l. (winter) and 1 in 18·25 l. (summer); solbar 4 kg. per 20 l. (winter) and 1 kg. per 100 l. (summer). In all cases the incidence of disease was reduced considerably when both winter and summer applications were given, salt and lime-sulphur giving the best results. The winter spray alone was ineffectual.

KELSALL (A.). **Experiments on the dust method of smut control.** —*Scient. Agric.*, iii, 9, pp. 303–307, 1923.

These experiments, conducted by members of the Annapolis Entomological Laboratory with Professor W. S. Blair, had for their primary object the testing of the fungicidal properties of various insectide-fungicide dusts. The experiments, however, also yielded results of practical value regarding the most efficient and cheapest method of controlling smut by seed dust treatment.

In the experiments carried out in 1921, Liberty oats were treated by sifting the dust over the seed, which was then turned over several times and bagged. Five oz. of dust were used to 20 lb. of grain. The following materials were used on the various plots. Plot 1: grain soaked in water 10 minutes, partly dried and then soaked in formalin, 1 pt. to 40 galls. [American] for 3 minutes, partly dried and sown immediately. Plot 2: control. Plot 3: dusted with 28·5 per cent. dehydrated copper sulphate mixed with 71·5 per cent. infusorial earth (which acted as an inert filler). Plot 4: dusted with 28·5 per cent. dehydrated copper sulphate and 71·5 per cent. hydrated lime. Plot 5: the dust used was made as follows: 53 parts of stone lime were slaked with a little water, 40 parts of crystal copper sulphate being added meanwhile, and the whole thoroughly mixed. The copper in this dust was in the form of an oxide or hydrated oxide. Plot 6: dust contained 10 per cent. dehydrated copper sulphate, 5 per cent. calcium arsenate, and 85 per cent. hydrated lime—a general dust then in use. Plot 7: similar to plot 4 but the grain was moistened with water before applying the dust. The germination of the seed did not appear to be injured in any plot, and the percentages of smut present in the plots were (1) 52·1, (2) 61·3, (3) 2·5, (4) 16·2, (5) 45·3, (6) 72·9, (7) 9·5, from which it is evident that plot 3 gave the only results for practical purposes, and that wetting the grains before dusting with copper sulphate and lime increased the efficiency of this treatment.

In 1922 Liberty oats were again used, but the dusting was carried out in a small churn. In each case 4 oz. of dust per bushel of seed were used. Thirty plots were sown, each one-thirtieth of an acre in extent. The trials were divided into three series. Series A, with dehydrated copper sulphate (10 per cent. Cu) mixed respectively with the following fillers, infusorial earth, calcium carbonate, gypsum, talc, hydrated lime, gave 4·8, 5·4, 7·6, 2·0, and 7·0 per cent. smut respectively; the first mixture, with the proportions altered so as to contain 5, 10, 20, 30 per cent. of Cu gave 18·3, 7·1, 3·4, and 3·3 per cent. smut respectively; the control gave 46·4. Series B, with the following pure chemicals, gave the percentages of smut indicated: dehydrated copper sulphate (3·9), copper carbonate (1·5), copper oxide (24·1), copper sulphide (1·9), copper arsenate (3·4), copper arsenite (1·0), dehydrated aluminium sulphate (17·7), dehydrated nickel sulphate (3·6), dehydrated cobalt sulphate (4·9), and the control 33·6. Series C, with certain miscellaneous dusts, yielded the following percentages of smut: 50 per cent. dehydrated copper carbonate and 50 per cent. tobacco dust (6·8), copper carbonate (25 per cent. Cu) (1·1), prepared Bordeaux (12 per cent. Cu) (8·5), sulphur dust (3·5), inoculated sulphur dust (2·8), whilst the control gave 46·4.

From the above results it is seen that control was in no case perfect but approached perfection in certain cases. Copper arsenite was the most effective substance used, but has the disadvantage of being highly poisonous. From series A, it would appear inadvisable to attempt diluting dehydrated copper carbonate with inert materials, although talc gave good results in this connexion. The fairly effective control with sulphur dusts is important in view of the cheapness of the material, and the results may be improved by using the substance in greater proportions.

When absolute control of smut is not required, the author tentatively recommends the use of copper carbonate dust, or sulphur dust (about one-sixth of the cost of the former) in somewhat larger quantities.

AUSBORN. **Ein Heisswasserbeizversuch gegen den Flugbrand.** [A hot water steeping experiment against loose smut.]—*Deutsche landw. Presse*, l, 14, pp. 125–126, 1923.

In the spring of 1922 the writer immersed some Bordeaux wheat seed, heavily infected with loose smut [*Ustilago tritici*], in water heated to a temperature of 50° to 52°C. for ten minutes, after a preliminary soaking in cold water. After rinsing in cold water the treated grain was spread out to dry. A very good yield was obtained and there was a reduction in the number of smutted ears of one-half to one-third compared with the untreated controls. Complete prevention of the disease, however, appears to be impossible by this means even when the directions of the Biological Institute [Dahlem] are exactly followed, as in the present instance.

MAHNER (A.). **Feldversuch mit Beizmitteln zur Bekämpfung des Haferbrandes.** [Field experiments with disinfectants for the control of Oat smut.]—*Wiener landw. Zeit.*, lxxiii, 13–14, pp. 50–51, 1923.

In the spring of 1922 a series of experiments in the control of oat smut [*Ustilago avenae*] was carried out at Hartmanitz, Czecho-Slovakia. The soil consisted of gneiss decomposed sand, and the slightly sloping field was situated 640 metres above sea-level. The following fungicides were tested; copper sulphate, germisan, formalin, segetan, uspulun, and the Dupuy and Aussig seed steeps. The seed was procured from heavily infected 1921 crops.

The best results were obtained by steeping the seed for four minutes in a 1 per cent. copper sulphate solution after washing it in clean water (Linhart's method), or for half an hour in 0·5 per cent. germisan. The latter method is preferable in practice, as the slightest neglect with copper sulphate leads to a serious reduction or even complete failure of germination.

MÜLLER (H. C.). **Die Bedeutung der ertragsteigernden Wirkung einiger Beizstoffe für die Volksernährung.** [The significance for the national food supply of the increased productivity ensured by certain disinfectants.]—*Nachrichtenbl. deutsch. Pflanzenschutzdienst*, iii, 8, pp. 57–58, 1923.

The results of experiments conducted at the Halle Phytopathological Experiment Station have shown that the use of stimulating

seed disinfectants (i. e. those containing arsenic, phenol, mercury, and the like) increases the yield of the resulting crops in a very high degree. Thus in one instance the yield per acre of wheat treated with a stimulating disinfectant was increased by about 5 dz. per hect. [4 cwt. per acre], and in another oat crop was augmented by about 2·5 dz. per hect. [2 cwt. per acre]. As the wheat had only absorbed about 51 gm. and the oats approximately 153 gm. of the fungicide, the increase in the yield was out of all proportion to the expenditure on material. This result is approximately equal to that obtained by the application to the soil of 15 kg. nitrate nitrogen.

It is pointed out that, by the judicious use of fertilizers and stimulating seed disinfectants, an average increase in the cereal yield of 4 dz. per hect. [3·2 cwt. per acre] could be obtained, and the necessity of importing large quantities of foreign grain thereby obviated.

BINZ (A.) & BAUSCH (H.). **Versuch einer Chemotherapie des Gerstenbrandes.** [An experiment in the chemotherapeutical treatment of Barley smut.]—*Zeitschr. angew. Chemie*, xxxv, 41, pp. 241–243, 1922.

The successful results of empirical chemotherapy in human infectious disease suggested to the authors that similar treatments may be applied to diseases of plants. Ehrlich's plan was to determine the chemotheropeutical index [the ratio of the minimum healing concentration of the medicine, (c) or *dosis curativa*, to the maximum dose the patient will stand, (t) *dosis tolerata* or *toxica*] for a number of chemicals, and choose the ones for experiment in hospitals in which the index [quotient c/t] was very small: the smaller the index the more certain and less risky being the cure.

The difficulty of applying these methods to plants lies in the absence of a blood stream in the latter. The authors were encouraged by Riehm's work, however (*Mitt. Biol. Reichsanst. Land- u. Forstwirtsch.*, xxi, p. 136, 1921), and attempted the problem. The method they adopted was as follows: spores of the covered smut of barley were introduced with the point of a flamed needle into a tube of the disinfectant to be tested. The tube was shaken and then allowed to stand 30 minutes, after which the liquid was filtered off and the filter paper left overnight exposed to the air to dry [no mention is made of washing]. They then spread out the filter paper, to which a number of spores were attached, on a Petri dish and added a nutrient solution of 0·5 per cent. calcium nitrate as recommended by Riehm, who found that this medium discouraged the development of moulds. The liquid formed a layer 2 to 3 mm. deep in the dishes. The latter were exposed to diffused light at room temperature and spores were taken every day and examined under the microscope to see how the germination had progressed. Using this method [with various concentrations of the disinfectant] they determined the minimum concentration necessary to inhibit germination (the *dosis curativa* of Ehrlich). Spores which were not disinfected but otherwise treated similarly germinated in 2 to 3 days.

For the determination of the maximum concentration the barley

seed would stand, healthy seed was placed in the disinfectant to be tested and treated in a similar way except that after drying [on the filter paper] the seed was placed on damp filter paper to germinate, and by determining the concentration which impaired germination the *dosis toxica* of Ehrlich was ascertained.

The authors tested the following substances at the concentrations given: formalin 0 to 1 per cent.; uspulun 0 to 2 per cent.; salvarsan and neosalvarsan 0 to 1·5 per cent.; atoxyl 0 to 1 per cent.; 4-aminophenyl-1-arsenoxide 0 to 1·5 per cent.; 3-amino-4-oxyphenyl-arsenoxide 0 to 1 per cent.; arsenic acid 0 to 1·57 per cent.; and three substances named A, B, and C, the composition of which is not disclosed, at 0 to 1·5, 0 to 2, and 0 to 3 per cent. respectively. None of these substances was any good except formalin, uspulun, and A, B, and C. The substance B was very good and C was excellent, the germination of the seed in the latter case not being impaired until 40 times the *dosis curativa* (0·05 per cent.) was used.

A principal result of these investigations is the knowledge of the fact that Ehrlich's conception of the chemotherapeutical index is applicable to vegetable as well as to human pathology.

RIEHM (E.). **Zur Chemotherapie der Pflanzenkrankheiten.** [Contribution to the chemotherapy of plant diseases.]—*Zeitschr. angew. Chemie*, xxxvi, 1, pp. 3–4, 1923.

Referring to the work of Binz and Bausch on the chemotherapeutical index [see last abstract], the author points out that the term 'chemotherapeutics' is strictly applicable only to the destruction by chemical substances of pathogenic organisms in the interior of cereal or other seeds. The steeping of cereal seed to protect it against smut spores adhering to the exterior, the spraying of vines against downy mildew [*Plasmopara viticola*], and other preventive measures are purely prophylactic. The only genuine chemotherapeutical remedies so far discovered are the cure of chlorosis of vines and fruit trees by spraying with, or injection of, iron sulphate, and the destruction of the *Fusarium* and stripe disease [*Helminthosporium gramineum*] organisms in the interior of seed grain by immersion in mercury salts.

The author's method of determining the [minimum] spore destroying concentration [*dosis curativa*] of a chemical substance (see *Mitt. Biol. Reichsanst.*, xviii, p. 19, 1920), has been modified somewhat as follows: a given quantity (0·3 gm.) of smut spores is placed in a test tube and shaken up with a small quantity of the fungicide, with which the tube is then filled to the brim. One prevents by this means any spores remaining attached to the glass and not being wetted. After half an hour most of the liquid is poured off and thrown away, together with any spores floating on the surface. The remaining spores are then thoroughly shaken and filtered through two separate filters, one of which is left to itself while the spores in the other are immediately washed with water several times. This washing at once prevents further action by the fungicide, which continues to act, however, on the spores in the other filter until they are dry, thus corresponding to normal field

conditions. Next day after the spores have dried, a small quantity of the spore mass is removed with a platinum needle and placed in a Petri dish in a solution of 25 per cent. calcium nitrate. The method of Binz and Bausch, whereby the entire filters are placed in the solution, is suitable for covered smut of barley [*Ustilago hordei*] but not for bunt of wheat [*Tilletia tritici*]. The spores of the latter do not germinate when sown in high spore concentrations and should not be used in quantities exceeding 5 mg. per 15 cc. of calcium nitrate. The spores of *U. hordei* germinate in two days and those of *T. tritici* in three to four days in diffused light at a temperature of 20° C. Direct sunlight or total darkness delays germination, as also do temperatures below 20° C. Spores treated only in water should be cultivated for purposes of comparison. There is little danger of the development of moulds in the solution; *Acrostalagmus* sp., however, has been known to occur occasionally.

The *dosis toxica* or *dosis tolerata* was ascertained by Binz and Bausch by exposing barley seeds to the fungicide, drying them, and spreading them out on damp filter paper for germination.

All the authorities are agreed that an accurate and reliable estimate of the germinating power of seed which has been immersed can only be obtained by testing at least 200 seeds. Even when a reliable estimate of germination has been obtained in these tests, however, the effects of the fungicide on the plants in the field cannot be exactly foretold. Numerous experiments have shown that while [percentage] germination is not in the least impaired by many solutions the seedlings do not thrive and are lacking in germination energy ['Triebkraft'] with the result that the stand is defective. This shows that the fungicide has in some way weakened the natural forces of the seed, which may retain sufficient energy to develop under optimum conditions in the laboratory but not when exposed to the rigours of the field. Hiltner has therefore devised the following system of ascertaining such effects on the constitution of the seed: the seeds to be tested (at least 200) are laid on a layer of damp brick dust in zinc tins, covered with another layer of damp brick dust 3 to 4 cm. in height and left for a fortnight. The energy of the seed is judged by the number of plants which have come up at the end of this time. In this connexion it must be remembered that different varieties of wheat vary considerably in their susceptibility to the same concentration of a chemical substance and a comparison between two fungicides should only be made when tests have been carried out on the same variety of wheat.

The theoretical fungicidal value of a chemical substance is determined as follows: the concentration at which germination energy or speed of germination is reduced by more than 10 per cent. is first ascertained, using at least five varieties of wheat. The next step is to discover the [minimum] concentration at which the spores of *Tilletia tritici*—the most important fungus in agriculture—are destroyed. The theoretical fungicidal value of the substance is obtained by dividing the concentration at which germination energy is reduced by more than 10 per cent. by the spore-destroying concentration. The higher the quotient, the better the results to be anticipated in field trials with the disinfectant in question. [This is approximately the reverse of the chemothera-

peutical index as calculated by Binz and Bausch and also by Gassner: see last and following abstracts.]

Spores of *T. tritici* steeped for 30 minutes in a 0·1 per cent. copper sulphate solution do not germinate in calcium nitrate and few do so after 0·01 copper sulphate. It might be assumed from these laboratory experiments that the spores were killed by 0·1 per cent. copper sulphate but this is not the case. Hecke has shown that normal germination is restored by rinsing them in diluted hydrochloric acid (0·5 per cent.). Probably in the field the humic acid in the soil is also capable, under certain conditions, of washing the copper off the spores adhering to treated seed, which would account for the appearance of smut on the plants from treated seed when sowing has been immediately followed by heavy rains. It is thus essential to confirm by field tests the results of laboratory experiments.

Gassner (G.). **Biologische Grundlagen der Prüfung von Beizmitteln zur Steinbrandbekämpfung.** [Biological principles underlying the testing of fungicides for seed treatment against bunt.]—*Arb. Biol. Reichsanst. für Land -und Forstwirtsch.*, xi, 5, pp. 339–372, 1923.

While field trials remain the most reliable means of determining the efficacy of the numerous new preparations released by chemical works for the disinfection of seed grain, they are extremely lengthy and costly, and too much dependent on uncontrollable factors such as climate, weather conditions, and lack of scientific training in farm staffs entrusted with the trials. These drawbacks call for laboratory methods which can be conducted under strictly controlled conditions within a short time. Some work has already been done in this direction by Riehm (*Mitt. Biol. Reichsanst.*, xviii, p. 19, 1920), who investigated in spore germination tests the fungicidal action of different chemical compounds on smut spores. It is obvious also that chemical works must test their preparations in the laboratory without, however, being quite clear as to how far their results apply in practice. As a matter of fact, the results of laboratory experiments, as hitherto conducted, seldom, if ever, agree with those of field trials, thus justifying doubts as to the value of such experiments. The present work is an attempt at developing a laboratory technique in conjunction with field trials so as to obtain numerical indices of the comparative value of the different fungicides offered to the public.

The efficacy of a disinfectant depends on two main factors: firstly, on its specific lethal action on the parasite, and, secondly, on its harmlessness for the host. The notion that both factors must be equally considered is old and was unconsciously applied even before pathogenic organisms were known. The numerical computation of the action of a therapeutical preparation on the host and on the pathogen, however, was first applied by Ehrlich (Die experimentelle Chemotherapie der Spirillosen, Berlin, 1910) to the testing and discovery of new remedies in human and animal pathology. According to this author the medicinal value of a chemical preparation is determined by its chemotherapeutical index, which is represented by the symbol ζ and is equal to c/t, c being the *dosis*

curativa and t the *dosis toxica* [see above, p. 551], both being calculated in relation to unity of weight of the animal body.

In 1918 the author began a series of experiments in the control of bunt of wheat [*Tilletia tritici* and *T. levis*] with the object of applying the principles outlined above to the treatment of plant diseases. The *dosis curativa* may be defined as the minimum concentration of a disinfectant which will destroy the spores of the fungus. The spores must therefore be treated in a certain way and the effect of the fungicide on their subsequent germination carefully noted. The method adopted in the present series of investigations was immersion of the bunt spores for one hour in the fungicide to be tested, at a temperature of 18° C., with subsequent rinsing. The germination medium used was a 0·1 per cent. solution of calcium nitrate in distilled water, the dishes being maintained at a constant temperature of 15° C. Under these conditions untreated spores germinated in 3 to 5 days, whereas the previous immersion in uspulun, formalin, or germisan delayed or prevented germination according to the strength of the concentration. It was frequently observed that spores treated with a solution which was sufficiently strong to control the diseases in the field completely, nevertheless germinated after weeks or months in the laboratory. Therefore the action of such solutions is not, strictly speaking, destructive but merely in a very high degree repressive. The results of field experiments with treated Schlanstedter summer wheat showed that even a slight retardation in spore germination (five days) greatly reduced the incidence of infection, while absolute control was secured when germination was delayed for seven to eight days. Hence the *dosis curativa* is represented by the minimum concentration of a solution which, under the conditions described above, retards germination for ten days. In the present series of experiments the *dosis curativa* was as follows: formalin 0·13 per cent.; germisan 0·12 per cent.; uspulun 0·08 per cent.; mercury cyanide (with a 17·5 Hg-content) far above 10 per cent.

The *dosis toxica* (equivalent to Ehrlich's *dosis tolerata*) is that concentration of a disinfectant which, at the end of a given time, shows the first indications of a deleterious effect on the grain. In calculating the *dosis toxica* several factors arise in connexion with the germination of the seeds which need consideration.

From experiments on the action of different formalin solutions on wheat grain, it was found that an increase of the percentage of germination was also accompanied by a corresponding improvement in the speed of germination. Conversely a lowering of the germination percentage gave also a retardation in germination. The full germination percentage, however, was also reached in certain cases of retarded germination. Thus immersion for one hour in 0·2 per cent. formalin resulted in a delay of germination of about eight hours, although practically all the seeds germinated. The decline in the germination percentage on the one hand and the retardation of germination on the other must therefore be considered in judging the effect of a fungicide on the treated seeds, and it is advisable that the figures for the *dosis toxica* should take into account both these effects.

When the injurious action on the seed increases there is a decline

in the germination percentage and, at the same time, an increase in the time taken for germination. The figure expressing the real effect on the grain is therefore found by the division of germination percentage by the speed of germination (expressed in days). In order to obtain comparative values between experiments not simultaneously undertaken, the quotient, germination percentage/speed of germination, is compared with that quotient obtained from seed treated only with water in place of the disinfectant. The quotient from the water treated seeds is taken to be equal to 100, and from this is calculated the values for seeds treated with the fungicides, which values are taken as the index figures of the effect of the fungicide on the grain.

The author's method of determining the *dosis toxica* was as follows: the seed (20 gm.) was immersed in at least 60 cc. of the fungicide for exactly one hour, rinsed, washed for 30 minutes in six changes of water, and dried. Seeds were also treated in water in the same way for control. At least 200 seeds were used in each germination test in each experiment and for the control 400 were used. The seeds were germinated on filter paper in Petri dishes in the dark at a temperature of 15° C. Every day they were examined, the standard for germination being a leaf and three healthy roots. The tests lasted 6 days. From data obtained in this way the percentage germination, the speed of germination, and finally the index figure (the control being 100) was calculated.

Tests have shown that the experimental error does not exceed 5 per cent. of the index figure as a rule, and all index figures under 95 per cent. indicate that there is a slight injury to the seed. The *dosis toxica* therefore is that concentration at which the index figure falls below 95 per cent. on the average in several parallel series of experiments. It is necessary always to use the same variety of cereal; the author used Strubes Schlanstedter summer wheat.

After having determined the *dosis curativa* and the *dosis toxica* by the methods described above, the calculation of the chemotherapeutical index is made by dividing the *dosis curativa* by the *dosis toxica*. In the case of the fungicides used in the author's experiments the *dosis curativa* was: formalin 0·13; germisan 0·12; uspulun 0·08, and mercury cyanide over 10: the *dosis toxica* was: formalin 0·1; germisan 0·35; uspulun 0·25; and mercury cyanide 0·9 (all in percentage strengths of the solution) and the index worked out as follows: formalin 1·3; germisan 0·34: uspulun 0·32; mercury cyanide (17·5 per cent. Hg) over 11. It will be seen that the resulting quotient places germisan and uspulun in a much more favourable light than formalin, while mercury cyanide occupies a very inferior position.

The above calculations of the chemotherapeutical index are made only in reference to the effect of the fungicide when used for immersion, and the author in the latter part of his paper discusses a modification of the method to express the efficiency of the fungicide applied by sprinkling. He determined the *dosis curativa* for sprinkling experimentally, taking wheat strongly infected with bunt, and using 25 gm. which was sprinkled with 5 cc. of disinfectant, the seed being then stirred for 2 minutes and immediately

after spread on a filter paper in a layer 1 cm. thick to dry. After drying the spores were germinated at 15°C. in 0·1 per cent. calcium nitrate solution. It was found that the *dosis curativa* from sprinkling was as follows: formalin 0·05; germisan 0·14; uspulun 0·33; mercury cyanide 2 per cent.

In order to define these differences between immersion and sprinkling the author introduces the sprinkling coefficient B (the number by which the factor c in immersion must be multiplied in order to obtain the *dosis curativa* (cB) as determined for sprinkling). Hence the factor B for formalin is 0·5 [the author taking c = 0·1 in this calculation]; for germisan 1·2; for uspulun 4·1; and for mercury cyanide less than 0·2.

The determination of the *dosis toxica* by sprinkling was made and it was found that the alteration in the effect of the sprinkling as compared with immersion moved in the same direction as in the case of the *dosis curativa*. Hence by multiplying the factor for immersion by B he obtained a figure approximately equal to that of the *dosis toxica* for sprinkling, i. e. the concentration in sprinkling which produces the first signs of injury to the seed.

In conclusion the author discusses the chemotherapeutical index of the four substances tested. He points out that formalin with an index of 1·3 is unsatisfactory, as a certain amount of seed injury must be expected at a concentration which will kill the fungus spores. Germisan and uspulun with indices of 0·34 and 0·32 respectively are quite satisfactory, but mercury cyanide with an index of more than 10 is extraordinarily unsatisfactory. Generally speaking, the limits of the index of a satisfactory substance should not be allowed to exceed 0·5.

Gassner (G.) & Esdorn (Ilse). **Beiträge zur Frage der chemotherapeutischen Bewertung von Quecksilberverbindungen als Beizmittel gegen Weizenstinkbrand.** [Contributions to the problem of the chemotherapeutical value of mercury compounds as disinfectants against bunt of Wheat.]—*Arb. Biol. Reichsanst. für Land- und Forstwirtsch.*, xi, 5, pp. 373-385, 1923.

A series of experiments, based on the principles outlined in the preceding abstract, was conducted with a view to ascertaining the fungicidal properties of a number of substances, the mercury content of all of which was equalized at 17·5 per cent. by the addition of the necessary quantity of sodium chloride and sodium sulphate.

The values for the inorganic mercury preparations tested were as follows: (P 1 = Preparation No. 1) Corrosive sublimate; c (*dosis curativa*) 0·025; t (*dosis toxica*) 0·1; c/t (chemotherapeutical index) 0·25; cB (*dosis curativa* by sprinkling) 0·08; B (sprinkling coefficient) 3·2. (P 6) Disodium mercurous thiosulphate; c 3·0; t 5·5; c/t 0·55; cB 3·5; B 1·2. (P 4) Mercuric cyanide; c over 10; t 0·9; c/t over 11; cB 2·0; B 0·2. (P 3) Mercuric oxycyanide; c 0·1; t 0·28; c/t 0·36 cB 0·21; B 2·1. (P 5) Double salt of the cyanides of mercury and potassium; c over 10; t 0·9; c/t over 11; cB 3·0; B < 0·3.

The following list gives the corresponding values for the organic preparations tested: (P 30) Mercury methyl iodide; c 0·001; t 0·015; c/t 0·07; cB 0·008; B 8·0. (P 21) Sodium hydroxynitrophenylmercury sulphate; c 0·07; t 0·3; c/t 0·23; cB 0·28; B 4·0.

(P 15) Sodium hydroxychlorphenylmercury sulphate; c 0·08; t 0·25; c/t 0·32; cB 0·33; B 4·1. (P 8) Hydroxysulphophenylmercury hydrogen sulphate; c 0·18; t 0·7; c/t 0·26; cB 0·4; B 2·2. (P 7) Sodium salt of hydroxycarboxyphenylmercuric hydroxide; c 2·0; t 2·5; c/t 0·8; cB 1·0; B 0·5. (P 10) Sodium salt of methylhydroxycarboxyphenylmercuric hydroxide: c 0·22; t 1·1; c/t 0·2; cB 0·4; B 1·8. (P 19) Sodium hydroxychlorphenylmercury sulphate, dissolved in sodium thiosulphate; c 2·5; t 2·4; c/t 1·0; cB 1·5; B 0·6. (P 17) Sodium hydroxymethylphenylmercury sulphate, dissolved in sodium thiosulphate; c 3·2; t 2·5; c/t 1·3; cB 1·3; B 0·4. (P 25) Sodium salt of hydroxymethylphenylmercuric cyanide; c 0·12; t 0·35; c/t 0·34; cB 0·14; B 1·2. (P 28) Sodium salt of mercury carboxyphenyl cyanide; c 0·2; t 0·8; c/t 0·25; cB 0·6; B 3·0. (P 29) Sodium salt of mercury hydroxycarboxyphenyl cyanide; c far above 5; t 1·6; c/t far above 3; cB 2; B much $<$ 0·4. (P 23) Sodium salt of symmetrical dihydroxy mercury diphenyl; c 0·05; t 0·17; c/t 0·29; cB 0·18; B 3·6. (P 24) Sodium salt of symmetrical dihydroxydicarboxy mercury diphenyl; c 1·0; t 1·4; c/t 0·7; cB 1·0; B 1·0. (P 27) Sodium salt of mercury phenolphthalein; c 1·8; t 1·3; c/t 1·4; cB 2·0; B 1·1. (P 22) Sodium salt of mercury fluorescein c 2·0; t 1·7; c/t 1·2; cB 3·0; B 1·5. [The formula for most of these compounds is given.]

Four decisive factors must be considered in determining the utility of a mercury disinfectant. These are (1) a sufficiently low chemotherapeutical index; (2) a sprinkling factor approximating as nearly as possible to the figure 1: this factor indicates the higher or lower concentration to be employed in the sprinkling method in order to obtain the same results as with immersion, and the more closely the strengths for both methods coincide the more valuable is the substance in question; (3) the preparation should combine efficiency with as low a mercury content as possible in order to promote its use on a commercial scale; (4) the degree of toxicity to human and animal organisms should be as low as possible. As regards the last-named point the majority of the organic mercury compounds are less toxic than some of the inorganic, e. g. corrosive sublimate. Other things being equal, these relatively innocuous products should be preferred.

An analytical survey of the values given above shows that the mercury compounds with the lowest *dosis curativa* have the most favourable chemotherapeutical index and vice versa. Thus all the preparations with effective action on the spores are at the same time comparatively harmless to the seed; the *dosis curativa* in such cases is $\frac{1}{3}$ to $\frac{1}{5}$ smaller than the *dosis toxica*. On the other hand the higher the *dosis curativa* the less favourable is the relation between spore destroying and seed impairing activity.

A comparison between the chemotherapeutical index and *dosis curativa* on the one hand and the sprinkling coefficient B on the other also reveals, with striking regularity, that the mercury compounds with the most favourable chemotherapeutical index and the lowest *dosis curativa* generally have the highest sprinkling coefficient and vice versa (cf. P 30, P 1, P 23 with P 4, P 5, P 29).

The chemotherapeutical index is the fundamental criterion for the determination of a given substance. All the compounds in

which this index is higher than 0·5 must be rejected as disinfectants since the necessary strong concentrations involve risk of injury to the germinative capacity of the seed.

In addition to P 30, P 1, P 23, P 21, and P 15, shown above to combine low concentrations with high fungicidal efficiency, P 10, P 28, P 8, P 25, and P 3 may also be recommended.

By far the most efficient of the products tested was P 30, mercury methyl iodide, but on account of the extremely poisonous nature of the compound it could not possibly be recommended for practical purposes.

It was difficult to determine the respective merits of some of the other compounds tested. Corrosive sublimate combines fungicidal efficiency with a low spore destroying concentration, 0·05 per cent. for immersion and 0·15 to 0·2 per cent. for sprinkling. On account of its toxicity to animals, corrosive sublimate may well be replaced by P 25, which also has a very favourable sprinkling coefficient. P 3 is inferior to P 23, P 21, and P 15 in respect of the *dosis curativa* and the chemotherapeutical index, but superior to these preparations in its very favourable sprinkling coefficient. Any of these compounds may safely be recommended as disinfectants, adequate quantities for practical purposes being approximately for immersion: P 3 0·2 per cent.; P 23 0·1 to 0·15 per cent.; P 21 0·2 per cent.; P 15 0·2 per cent.; and for sprinkling: P 3 0·4 per cent.; P 23 0·3 to 0·4 per cent.; P 21 0·75 per cent.; P 15 0·75 per cent.

The remaining three preparations with favourable chemotherapeutical indices, P 8, P 28, and P 10, require to be applied at comparatively high concentrations and are therefore impracticable on economic grounds.

Discussing the comparative efficacy of various inorganic and organic mercury compounds, the author points out that the efficiency of corrosive sublimate compared with mercuric oxycyanide and other compounds is connected with the question of dissociation. Of the organic mercury compounds P 30 combines the simplest construction, $CH_3—Hg—I$ with the utmost efficiency, far exceeding that of corrosive sublimate. In comparison with this simple combination of the fatty series, the benzene compounds were much less efficacious. An increased carbon content appears to depress the activity of the mercury, while the introduction of a carboxyl group into the mercury compounds produced a similar effect.

P 23, which is constitutionally incapable of dissociation, is almost equal in efficacy to P 1, and there are various other instances (e.g. P 25) of fungicidal efficiency in the absence of dissociation. P 27 and P 22, the structures of which are exceedingly complex, are of no value for seed disinfection in spite of their high reputation in the medical world.

In preparations where the sprinkling coefficient B is lower than 1, the more favourable effect of the sprinkling method is due to the prolongation of the disinfection process and the increased efficacy of the preparation owing to the absorption and consequently augmented concentration of the solution. In preparations with a high sprinkling coefficient, however, the reduced efficiency is due to the deprivation of the toxicity of the product by the seed. Experiments showed that the adsorption coefficients of the simple

mercury compounds CH_3HgI and CH_3HgOH were very high; a portion of the mercury content of the solutions is taken up by the dead outer layers of the grain and thus rendered innocuous to the externally adhering fungous spores and to the inner tissues of the seed.

The fundamental difference between immersion and sprinkling is that in the former method large quantities of disinfectant are brought into contact with a relatively small amount of seed and are thus not noticeably deprived of their toxicity, whereas in the latter method the potential loss of toxicity is increased with the diminution of the amount of liquid. The inverse ratios between the *dosis curativa* and sprinkling coefficient, which indicate that mercury compounds with a low *dosis curativa* have a high sprinkling coefficient and vice versa, are readily explained by the fact that sprinkled seed deprives efficacious compounds at weak concentrations of toxicity more completely than inferior fungicides at high concentrations.

In discussing the importance of having a relatively high *dosis toxica* in obtaining a low chemotherapeutical index, the author points out that only those fungicides can exercise a toxic action on the seed which penetrate to the interior, after traversing the dead outer layers of the pericarp and testa, which, as stated above, adsorb a certain amount of the solution. Thus the liquid first reaches the interior as an innocuous solution; it is only after protraction of the process or an increase of the concentration, resulting in a saturation of the outer layers with the fungicide, that the toxic solution penetrates the seed and the *dosis toxica* is reached.

An ideal fungicide should contain as little mercury as possible, have the lowest possible chemotherapeutical index, and be equally efficient both in immersion and sprinkling. The two first requirements are mutually compatible, but not the third, since the same cause which results in the favourable chemotherapeutical index removes the sprinkling coefficient farther away from 1 in an upward direction. Disinfectants which have to be applied at a ten times higher strength for sprinkling than for immersion are impracticable owing to the impossibility of securing the necessary exactitude on a large agricultural scale.

It has already been shown [see preceding abstract] that formalin combines a very unfavourable chemotherapeutical index (1·3) with a strikingly low sprinkling coefficient (0·5). Chromic acid behaves similarly, while ammoniacal copper oxide and sulphuric acid unite a very low chemotherapeutical index with an extremely high sprinkling coefficient.

DUFRÉNOY (J.). **La transmission des maladies des plantes par voie biologique.** [The transmission of plant diseases by biological means.]—Reprint of a paper read before the *Société de Pathologie comparée* on 10th April, 1923, 8 pp., 2 figs., 1923.

The author reviews the various biological means of transmission of plant diseases, dealing briefly with cases where one parasite opens the way to another by simple wounding of the host tissues. Wounds caused by cutting tools act in a similar manner, but in these cases the parasitic organism may be inoculated at the same

time, if the implement has previously been used on diseased plants. Both man and domestic or wild animals may carry diseases considerable distances, the former on clothing and boots, and the latter on pelt, hoofs, and the like. An equally important source of infection is the alimentary canal of animals, *Fusarium* wilt of melon (*F. solani*), for instance, being often transmitted through larval faeces. In the soil, nematodes and other insects transport bacteria and spores from one root to another.

The relationship of predatory animals to cryptogamic organisms is frequently made closer by the predilection of the former for parasitized tissues. Thus, in the American pine forests squirrels are fond of gnawing the tumours produced by a species of *Peridermium*, the spores of which are inoculated into healthy pines subsequently attacked by these animals. Many insects have a preference for galls and tumours on account of their succulent tissues. Cases of infection have been traced to the symbiotic relationship existing between insects and fungi (i.e. *Xyleborus dispar* always carries in its pharynx *Monilia candida*, which grows in its bore holes and on which it flourishes) and even ordinary soil organisms, such as *Bacillus mycoides*, have been isolated from tumours, a species of *Chermes* being responsible for the transmission of the organism, thus indicating that a pathogen need not necessarily be obtained from a diseased plant.

But beyond being a simple carrier of, or living in symbiosis with, a parasitic organism, an insect may form with the plant an alternative host, in which the parasite completes its life cycle. The incubation period sometimes necessary for the transmission of diseases of the mosaic type suggests this possibility.

Informazioni [Notes.]—*Boll. mensile R. Staz. Pat. veg.*, iv, 1-3, pp. 13-31, 1923.

Mancini in the *Coltivatore* of November-December, 1922, publishes the results of his investigations into a malformation ('ginocchiatura') of the ears of wheat, which, however, only occurs rarely and is of little economic importance. The most usual symptom is a kink in the last sheath below the ligular collar and plants affected become severely deformed. In affected ears a certain sterility of the flowers is found to occur, especially in the portion above and in that immediately below the kink in the unexpanded ear. The weight of individual grains in deformed ears is slightly higher than normal, but this is largely compensated by their small numbers due to the sterility of the flowers. The author's opinion is that the trouble is due to traumatic causes produced by strong winds, and experiments with some varieties of Todaro on soil heavily treated with stable manure have demonstrated that trophic conditions have a great influence on the disease. It has been found possible to reproduce the disease by bending the last sheath, before the ear emerges. The author has also noted a singular malformation in certain late varieties of grain, characterized by twisted and shortened ears and by an undulating or zigzagging rachis, which he thinks is due to unduly accelerated and disharmonious growth in the last stages of development.

In the *Giornale d' Agricoltura della Domenica* of 4th February,

1923, Boni gives an account of tests carried out with lime-sulphur (20° Baumé diluted to 60–80 per cent. strength) in the winter treatment of fruit trees. The results are stated to have been satisfactory so far as apple mildew is concerned.

Gramatica in the Trentino province, and Topi in that of Senese, have carried out tests with copper preparations for the control of the vine *Peronospora* [*Plasmopara viticola*], which they discuss in the February number of *Italia agricola*. The first-named author obtained poor results with De Haen's colloidal copper in 1 per cent. solutions, as well as with List's of 0·5 per cent. strength, and he ascribes the failure to the minute quantities of copper contained in these preparations. Topi experimented with 'Nosperal', prepared by Meister, Lucius, [and Brüning], of Hoechst [see this *Review*, ii, p. 223], which contains copper in combination with resin and is sold in the form of a very fine, grey powder. This is dissolved in water in the proportion of 1 : 1000 and 0·5 per cent. lime is added. The results were satisfactory, but not more so than those obtained with ordinary Bordeaux mixture.

SEAVER (F. J.). **Mycological work in Porto Rico and the Virgin Islands.**—*Journ. New York Bot. Gard.*, xxiv, 281, pp. 99–101, 1923.

A brief account is given of a ten weeks' visit paid by the author to Porto Rico and the Virgin Islands at the request of the Insular Government to study the fungi of these Islands, more especially those which attack coffee and citrus crops. In 1918 a summary of the mycological work carried out in Porto Rico appeared in the form of a check list of the local fungi (*Journ. Dept. Agric. Porto Rico*, ii, 3, 1918) and this work is at present being extended and revised by the writer and Mr. C. E. Chardon, Sugar Expert at the Insular Experiment Station.

Altogether, over a thousand fungi were collected, a considerable number of which are new to science, and detailed reports of the results of microscopical examination of the new material will be published in due course. Particular interest attaches to the specimens collected in the Virgin Islands owing to the scarcity of the information on the subject hitherto available.

MORSTATT (H.). **Einf hrung in die Pflanzenpathologie. Ein Lehrbuch für Land- und Forstwirte, Gärtner und Biologen.** [Introduction to Plant Pathology. A textbook for agri- and sylviculturists, gardeners and biologists.]—Sammlung Borntraeger, i, Berlin, 159 pp., 4 figs., 1923.

The present little volume is the first to appear of a series in course of publication in Berlin under the title 'Sammlung Borntraeger', the purpose of which is to supply students and practical workers in a compact but yet strictly scientific form with outlines and general principles of various branches of natural science. In its preface the aim of the author is stated to be to attempt to unite applied botany in its relation to plant diseases with economic entomology in a single branch of applied biology.

The book is divided into four chapters, namely: 1. Identification of plant diseases; 2. Etiology of plant diseases; 3. Causes of plant

diseases; 4. Plant protection. The compilation is well arranged and clearly written, and the discussions on the pathological anatomy and physiology of plants in chapter II are of particular interest.

FERDINANDSEN (C.) **Ukrudtets Betydning for plantesygdomme.** [The importance of weeds in plant diseases.]—*Tidsskr. for Landøkonomi*, 6, pp. 265–278, 1923.

In the first section of this paper the author quotes a number of statistics illustrating the part played by weeds in depriving cultivated plants of their proper share of water, potassium, phosphorus, nitrogen, and other nutrient constituents of the soil. The utility of weeds as cover crops is also briefly explained.

The second section is devoted to a discussion of weeds as carriers of infectious plant diseases. Clover, cereal, and other crops cultivated near railway banks, roadsides, chalk pits, or waste ground are readily attacked by fungous diseases, which originate on the related wild hosts. In many cases, however, the causal organism has been introduced with cultivated plants from abroad and thence spread to the wild indigenous hosts, e.g. gooseberry mildew (*Sphaerotheca mors-uvae*) and oak mildew (*Microsphaera alphitoides*) [*M. quercina*]. The cabbage fungi *Pythium de Baryanum*, *Cystopus candidus*, and *Plasmodiphora brassicae* were certainly already present on their wild hosts at the remote epoch when cabbage was introduced into Denmark. Recent investigations have shown that *Cystopus candidus* is divided into several biological strains, the spores from radishes being capable of infecting only 50 per cent. of the inoculated mustard plants and 1 per cent. of cabbage seedlings.

Both *Peronospora schachtii* and *Uromyces betae* are found on the wild beet; *Hypochnus solani* occurs on chickweed, &c.: *Puccinia graminis* spreads from various wild grasses to rye and oats. Certain species of juniper are indispensable to the development of *Gymnosporangium* on apple and pear trees: *Puccinia pringsheimiana* requires the proximity of various species of *Carex* to complete its life cycle. Wart disease (*Synchytrium endobioticum*), powdery scab (*Spongospora subterranea*), and leaf roll disease of potatoes are all transmissible to deadly nightshade.

NARASIMHAN (M. J.). **Casein as an adhesive in spraying against Areca koleroga.**—Reprinted from *Journ. Mysore Agric. & Exper. Union*, v, 1, 4 pp., 1923.

For the last twelve years the resin-soda-Bordeaux mixture (5–5–24 plus 2 lb. resin and 1 lb. soda heated in 1 gall. water) has been used with success in the control of the 'koleroga' disease [*Phytophthora arecae*] of the areca palm [*Areca catechu*] in Mysore [see this *Review*, ii, p. 22].

Experiments were conducted in the laboratory to ascertain the efficacy of casein as a substitute for resin-soda. The Bordeaux mixture was first prepared in the usual way. To 24 galls. of this mixture was added 1 gall. of solution containing 0·5 lb. of casein and 0·5 lb. of lime. Glass plates were sprayed with resin-soda-Bordeaux and casein-Bordeaux, dried in an oven, and then placed

under an artificial shower of water for eight days. On re-drying, the casein-Bordeaux was found to be still intact on the plates while the resin-soda-Bordeaux showed signs of washing off. In the field casein spraying was tried in areas where the rainfall varied from 100 to 300 inches, the operation being carried out in June and July while the nuts were immature. The results of the tests were very satisfactory, the incidence of the disease on the sprayed trees being very low indeed. The occasional instances of infection were chiefly found in areas where showers of rain had fallen soon after the application of the mixture. The use of 0·25 lb. of casein appears to give as good results as that of 0·5 lb.

Casein possesses several advantages over resin-soda. It is easier to use and is readily obtainable in the Bangalore and Kolar districts, while resin-soda has to be imported. Owing to the smaller quantities required, the cost of the spraying is reduced by one rupee per acre.

Casein-Bordeaux forms a less conspicuous coating on the nuts than the resin-soda-Bordeaux, partly on account of its natural bluish colour and also because of its very fine spreading qualities. The film adhering to the surface can, however, be clearly seen even after the heavy rains.

WEIMER (J. L.) & HARTER (L. L.). **Temperature relations of eleven species of Rhizopus.**—*Journ. Agric. Res.*, xxiv, 1, pp. 1–39, 23 graphs, 1923.

It has previously been shown, in connexion with the soft rot of sweet potatoes produced by various species of *Rhizopus* [see this *Review*, i, p. 272] that temperature played an important part in the process of infection. The fungi were placed roughly in high, low, and intermediate temperature groups. In the present paper the effect of temperatures on the spore germination, mycelial growth, and fruiting of eleven species of *Rhizopus* is discussed. These species fall into three groups as regards their response to temperature, the time required for germination to begin (i.e. the hours necessary for germ-tubes to reach the length of the diameter of the spores) being used as the measure of the influence of the temperature. *R. chinensis* has maximum and optimum temperatures higher than any of the other species (52° and 43° to 45° C. respectively); *R. nigricans*, *microsporus*, *reflexus*, and *artocarpi* constitute a group having low optima (*nigricans* and *microsporus* 26° to 28°, *reflexus* 30° to 32°, *artocarpi* 26° to 29°) and a low maximum (34°, 38°, and 34·5° respectively); while *R. tritici*, *nodosus*, *delemar*, *oryzae*, *arrhizus*, and *maidis* form an intermediate group (optimum 36° to 38°, maximum 45·5°). Discussing the results obtained, the authors point out that the cardinal temperatures for spore germination, growth, and fruiting of the fungi studied vary somewhat. In general, spores will germinate at a temperature too low for mycelial growth, and a higher temperature is required for fruiting than for growth. The optimum for germination is always higher than that for growth and fruiting, while in most cases the optimum for fruiting is about the same as that for growth. The optimum for fruiting is often not so well defined as that for growth, and the latter less so than for spore germination. In each case there is a gradation

from the maximum at which the spores will germinate to that at which fruiting will take place, the maximum for growth being about midway between that for germination and that for fruiting.

The effect of temperature on the continued growth of the germ-tubes was next studied. This was done by measuring the daily growth increment in Petri dishes. Graphs are given (the growth being plotted against temperature) of the eleven species. The minimum temperature for growth varies with the time for the first 5 to 15 days according to the species, after which the true minimum, below which growth will not take place regardless of time, is reached. With reference to the maximum temperature, although the graphs appear to indicate that this did not change, very careful measurement showed that a so-called shifting of the maximum did occur in some cases. Most of the fungi appeared to reach their maximum rates of growth during the second 24-hour period.

The results of experiments on the influence of temperature on fruiting showed that this takes place over a considerable temperature range. The optimum for some species is sharp and easily determined, while in others it extends over several degrees. Tables are given of the maximum, optimum, and minimum temperatures for spore germination, mycelial growth, and fruiting for each of the eleven species studied.

Further studies were made concerning certain environmental factors influencing germination and growth. The temperature at which the spores are produced influences in some degree the rate of germination and the early period of the growth of the resulting mycelium. Spores of *R. nigricans* produced at 10° C. germinated in 30 minutes less time than those formed at 20° and 26°. Spores of this species from different cultures grown under similar conditions germinated equally well up to 20 days irrespective of age.

Spores of *R. nigricans* germinated in a considerably shorter time in a nutrient solution than in water. Sweet potato decoction was the best liquid and string bean agar the best solid medium tried. In the comparative tests this fungus grew nearly twice as fast on string bean as on Irish potato agar. The presence of 20 per cent. dextrose in Irish potato agar changed the cardinal temperatures of the strains of *R. nigricans* studied by 1° to 2° C. *R. nigricans*, the most virulent member of this genus, is somewhat limited in its scope under natural conditions by temperature relations. The spores in the experiments described in the present paper were invariably killed at 35° C. and growth was very sparse and slow at 6·5° C. At 1·5° no appreciable development was made on potato agar in 30 days.

Harter (L. L.) & Weimer (J. L.). **The relation of the enzym pectinase to infection of Sweet Potatoes by Rhizopus.**—*Amer. Journ. of Botany*, x, 15, pp. 245–257, 1923.

The cause of soft rot of sweet potatoes in storage has long been suspected to be *Rhizopus nigricans*, although the causal relation of this fungus has hitherto been somewhat difficult to prove. The authors' investigations have shown that *Rhizopus nigricans* cannot infect sweet potatoes through the unbroken skin, and that infection

is only rarely produced by smearing spores and hyphae on a freshly cut surface. However, when the fungus is given a saprophytic start by growing on dead rootlets, in synthetic agar solidified on the cut surface of the potato, or in dead cells charred over a Bunsen burner, infection readily takes place. It can also be readily induced by growing the organism for a day or two in sweet potato decoction, the latter, with the mycelium, being poured into a 'well' made in the potato and then sealed over with a cover glass to prevent evaporation. Infection is accomplished only after the dissolution of the middle lamellae by means of the pectinase secreted in the growing hyphae [see this *Review*, ii, p. 418]. This enzyme appears to be secreted in advance of the growth of the fungus, a sterile zone always being present between the healthy and mycelium-infested regions. In almost all cases infection takes place in wounds where the fungus is able to secure a saprophytic start on some dead tissues. During the growth of the mycelium in these dead cells, the pectinase is produced which dissolves the middle lamellae of the living cells of the host. These cells then die and provide a suitable substance for the further development of the fungus.

Several other species besides *R. nigricans* were found to be able to cause decay in sweet potatoes, and in every instance the authors' experiments were duplicated with *R. tritici*. All the species were found to secrete pectinase and to macerate the host tissue.

The practical significance of these results is that wounding is a necessary preliminary to infection. Rough handling during harvesting, storage, and preparation for market should be avoided as far as possible.

The titles of 37 references to literature are cited.

NADSON (G. A.) & JOLKEVITCH (A. I.). **Spicaria purpurogenes n. sp. К вопросу об антагонизме микробов.** [*Spicaria purpurogenes* n. sp. On the question of antagonism of microbes.]—*Bull. Chief Bot. Gard. Russian Republic*, xxi, Suppl. i, pp. 1-12, 3 col. pl., 1923.

In one of the authors' cultures of common bread yeast (*Saccharomyces cerevisiae*) on malt agar a fungous contamination appeared, probably from the air, which produced a red pigment. The yeast cells near the fungus were killed and differentially stained as in a well-made microscopic preparation.

The fungus in question belongs to the genus *Spicaria* and is described as a new species *S. purpurogenes*. The mycelium is about 0·75 μ in diameter, septate, profusely branching, forming a weft of varying thickness according to the conditions of growth. By itself the mycelium is colourless but may when old become stained with its own pigment. It grows comparatively slowly, the production of conidia starting in one to two weeks, or sometimes later, depending on the cultural conditions; the latter also affect the colour of the pigment which may be yellowish, brownish, or red.

When about to fructify the mycelium appears to be covered with a white down. This is formed by nascent conidiophores which are tree-like and pyramidal in shape, 70 to 175 μ high, the branches

usually being disposed in whorls. Oblong bodies are generally detached from the tips of the branches and each of these bodies subsequently divides into two conidia by constriction in the middle; in some cases, however, chains of conidia are abstricted from the tips of the branches. The conidiophores may measure up to 3·75 μ at the base.

The conidia are elliptical, 1·5 to 2·25 by 2·25 to 3 μ, or occasionally round. Mature conidia give the fungus a greenish or dove-coloured appearance. When germinating they swell slightly and produce 1 to 4 germ-tubes.

In older cultures chlamydospores are found. These are elliptical or round cells with thick, clearly double, shining walls and dense contents, and are borne on short lateral branches.

Details are given of the cultural characters of the fungus which appear to show that carbohydrates (sugar or starch) stimulate the development of the fungus and that they are necessary for the production of the red pigment, which is favoured more by glucose than by saccharose, and by a weak acid than by a weak alkaline medium. Pigment production was better at 15° C. than at 23° C., but light had no effect on it.

The authors tested the reciprocal action of *S. purpurogenes* and *Saccharomyces cerevisiae* by sowing them in parallel or crossed streaks on agar plates. These tests showed plainly the aggressive behaviour of the fungus on the yeast, although the latter also affected the fungus by weakening its growth, suppressing the production of conidia, and stimulating the production of the red pigment. The toxicity of the red pigment on the yeast was clearly manifest, and there is no doubt that the struggle between fungus and yeast is carried on by chemical substances, by mutual poisoning, the advantage lying with the fungus. A transfer of red stained *Spicaria* to a fresh dish gives rise to normal unstained or very slightly stained cultures. The yeast therefore clearly stimulates the production of pigment. On media lacking carbohydrates the fungus does not produce the pigment even in the presence of the yeast.

Another species of yeast, *Nadsonia elongata*, proved to be even a weaker antagonist than the former one, although in this case sporulating cells are frequently seen whereas they were observed only once in the case of *Saccharomyces*. The common milk mould, *Oidium lactis*, was found to be still more susceptible, and similar results were obtained with *Endomyces vernalis*, a 'fat yeast'. *Penicillium glaucum* was also found to be susceptible to the *Spicaria*, being differentially stained by it, even in its young, immature conidia. The use of chemical substances and pigments by fungi to protect themselves from the aggressive action of other fungi and bacteria appears to be widely employed and to play an important part in the biology of micro-organisms.

MILLARD (W. A.) & BURR (S.). **The supposed relation of Potato skin spot to corky scab.**—*Gard. Chron.*, lxxii, p. 355, 1923.

Shapovalov's conclusion [see this *Review*, ii, p. 389] that skin spot of potatoes [previously referred to *Oospora pustulans*] is an immature stage of corky scab [*Spongospora subterranea*], would,

if satisfactorily established, be of considerable importance from a practical point of view. The pustules of skin spot are uniformly present on many well-known Scotch and English varieties of seed potato, including King Edward and Ally, and the prospect of corky scab being transmitted in this way is very alarming. However, as a result of thorough investigations on the pathogenicity of *Oospora pustulans*, details of which which will be published later, the authors believe they have obtained overwhelming evidence that skin spot is caused solely by *Oospora pustulans* and that it is in no way related to corky scab.

Une nouvelle maladie de la Pomme de terre. [A new Potato disease.]—*Bull. Agric. Algérie-Tunisie-Maroc*, xxix, 2nd ser., 4, p. 69, 1923.

The article reports the observation of *Spongospora subterranea* on potatoes in the coastal district of Algeria, and states that the disease is new to Algeria. No great losses are anticipated from this source as climatic conditions are rarely favourable to the development of the trouble, but brief instructions are given for preventing its spread.

PERRET (C.). **La dégénérescence des Pommes de terre.** [The degeneration of Potatoes.]—*La Vie agric.*, xxiii, 30, pp. 61–66, 6 figs., 1923.

During 1921 and 1922 the author carried out a series of investigations at the Merle (Loire) Experiment Station which furnished some data in connexion with leaf roll and other virus diseases of potatoes.

Early in 1921 a sack containing the tubers harvested from two pure line plants of the Paul Kruger [President] variety (susceptible to leaf roll) was supplied by Professor Quanjer to the Merle Experiment Station. Six of these tubers were each cut in two and the sections numbered 1 and 1′, 2 and 2′, &c. The halves 1 to 6 were planted in a field formerly under clover at a distance of 10 metres from other potatoes, in April 1921, and the corresponding sections 1′ to 6′ interspersed among plants of Institut de Beauvais suffering severely from leaf roll. The resulting plants in both plots were healthy and vigorous, but towards the end of August those in the vicinity of the diseased Institut de Beauvais began to show signs of leaf roll. The yield, however, was not reduced, and it was thought that the symptoms might be due to drought. In order to settle this point the tubers from each plot were kept separate, the crop from the tubers 1′ to 6′ being sent to the Grignon Experiment Station and those from the series 1 to 6 retained at Merle. In 1922 the plants grown from the latter were all healthy while those from the tubers 1′ to 6′ showed, with one exception, the typical symptoms of leaf roll. There seems, therefore, to be no doubt that infection was actually transmitted from the diseased Institut de Beauvais plants to the Paul Kruger plants.

Discussing the difficulty of accurately diagnosing leaf roll on account of the similarity of the symptoms to those produced by *Rhizoctonia*, blackleg [*Bacillus atrosepticus*], basal injuries, premature desiccation, and other causes, the author recommends the use

of the iodine water test. The leaves of suspected plants should be gathered in the early morning, boiled in Eau de Javelle, rinsed in ordinary water, dipped into water containing a few drops of iodine, and rinsed again. The leaves of diseased plants show a dark brown discoloration owing to the accumulation of starch. Leaves detached in the evening and placed overnight with the petioles in water retain their starch if diseased and lose it if healthy. According to Murphy [see this *Review*, i, p. 306] the results of this reaction are nearly always positive in cases of secondary leaf roll.

The part played by aphids in the transmission of virus diseases is briefly discussed, no original theories, however, being advanced. The effect of altitude on the incidence of these diseases has been studied in the Loire Department, but the investigations are complicated by the different reaction of certain varieties to high and low-lying situations. Thus, at 400 m. above sea-level the percentage of leaf roll among Institut de Beauvais potatoes increases from 30 to 90 in three years. On the other hand, Violette du Forez has been cultivated for fifty years in the mountains at an elevation of 1,000 to 1,200 m., and Merveille d'Amérique which 'degenerates' at 400 m. seems to recover in the mountains.

The method of field inspection adopted in the Loire Department is outlined. No field of Violette du Forez potatoes containing more than eight defective plants out of forty is passed. Excellent results are stated to have been obtained during the last three years by this method and the scope of the inspection is now to be extended by the Departmental Agricultural Bureau.

ARTSCHWAGER (E. F.). **Occurrence and significance of phloem necrosis in the Irish Potato.**—*Journ. Agric. Res.*, xxiv, 3, pp. 237–245, 6 pl., 3 figs., 1923.

Since 1916 the author has carried out investigations on the phloem of a large number of cultivated and indigenous South American varieties of potatoes in order to arrive at some definite basis as to what constitutes a healthy potato plant from the anatomical point of view and under what conditions the phloem will remain normal. To guard against erroneous diagnoses in the case of certain diseases, such as leaf roll, it is necessary to distinguish between normal histological changes and induced abnormal states, the latter alone being truly pathological.

The vascular tissue of the potato plant shows a bicollateral arrangement of its elements which is most clearly seen in the larger stem bundles. The primary phloem external to the cambium is composed of small groups of more or less continuous cells, but the groups constituting the inner phloem are very variable in size and scattered. Later secondary phloem elements become differentiated and participate in the translocation processes; the primary phloem groups remain active until the plant is mature. Apart from a slight thickening of the cell walls and occasional callus deposits on the plates of the sieve-tubes, there are no noticeable characteristic structural or chemical changes in the phloem of the mature plant.

Local necrotic changes in the parenchymatous tissue, however, due to a variety of causes, may be observed in any potato plant.

The study of numerous varieties at the Fort Lewis high altitude station, Colorado, revealed the influence of ecological factors on anatomical modifications in the vascular tissue. Thus, a superabundance of water induced a discoloration of the secondary elements of the wood and the primary xylem, the lumina being filled with a brown, gummy deposit. A greatly reduced water supply, or alternate wetting and drying, produced a dense and more strongly lignified wood. Shading reduced the xylem and the lignification of the cells was less pronounced. The occurence of these and other changes of a purely environmental character must not be confused with true pathological modifications.

External insect injuries frequently cause internal stem lesions and a dark discoloration of the tissues. In extreme cases entire cells or cell groups may be obliterated.

In connexion with the stem streak disease [see this *Review*, ii, p. 285] severe necrosis may be observed both in the inner and outer phloem, the cells being brownish in colour and the lumina may be partly closed by the pressure of the surrounding cells. The necrotic phloem groups, however, show no regularity either in vertical or lateral distribution and it remains to be seen whether this disease is definitely connected with leaf roll.

Stem sections of a typical leaf roll plant exhibit, as a diagnostic internal symptom, a necrosis and lignification of the phloem groups, which is described in some detail. When severe external symptoms are apparent the diseased groups pervade the entire plant, with the occasional exception of the underground organs. The distal stem region is commonly severely affected, and the basal stem region always shows necrosis when the symptoms appear early. The nodal tissues are more severely attacked than the internodal ones, especially in the early stages of the disease.

In the petiole and midrib necrosis may appear later but is usually correlated with the severity of the rolling. In the underground organs of diseased plants the phloem strands are usually normal but may show necrosis in bad cases.

The lateral distribution of phloem-necrosis is subject to a great deal of variation. Perfectly healthy phloem groups are often seen side by side with diseased ones. In the apical stem region, the first stages of necrosis are found in the external phloem and only later in both regions. In the base of the stem both inner and outer phloem may be attacked, but often the inner is completely destroyed whilst the outer remains healthy.

Before there is any apparent evidence of lignification of the phloem tissue, the development of the vascular tissue in the distal stem region shows a deviation from its normal course, represented by an irregular maturing of the xylem. Close examination of sections stained with phloroglucin and hydrochloric acid reveals a slight degree of lignification in parts of the walls of the phloem cells centrifugal to the depression in the cambium. The cells of the pericycle in this region have a greater radial diameter than the normal. The first cells to show lignification are usually those adjacent to the fibres, but occasionally lignification may start at the centre of a phloem group and extend centrifugally.

Prior to lignification of the phloem, a swelling of the walls of the

diseased cells extends centrifugally from the fibres. Large quantities of pectic substances in these walls are indicated by the deep blue colour imparted at this stage by ferrous sulphate and potassium ferrocyanide. Gradual lignification of the cells ensues, and in severe cases most or all of the primary phloem is destroyed. The intercellular spaces formed by the separation of the primary walls of adjacent cells become filled with a brown deposit, which at a certain stage takes the lignin stain. Following the gradual degeneration of the cells and subsequent loss of turgor, the phloem elements collapse unless rapid lignification lends rigidity to the walls.

Obliteration of the phloem is constantly associated with leaf roll, and Quanjer (*Meded. R. Hoog. Land-, Tuin. en Boschbouwsch.; Wageningen*, vi, p. 41, 1913) regards it as an infallible symptom of that disease. It is, however, also a concomitant of various other disturbances, and its value as a diagnostic internal symptom in leaf roll depends less on its mere presence than on its universal distribution and the absence of necrosis in other tissues.

BOTJES (J. O.). **Onbekende Factoren bij het kweeken van ziektevrij pootgoed.** [Unknown factors in the propagation of disease-free seed.]—*Tijdschr. over Plantenziekten*, xxix, 7, pp. 113–126, 1923.

The possibility of regenerating, by means of judicious selection, some of the more important potato varieties is discussed. Encouraging results in this direction have been obtained in Friesland with the Eigenheimer variety, and in several different localities with Roode Star, Bravo, and Zeeuwsche Blauwe. In Germany several growers have succeeded in selecting resistant strains of the 'degenerating' Industrie variety. There are, however, limits to the efficacy of this method, as has been shown by the repeated failure of attempts to cultivate the Eigenheimer and Paul Kruger [President] varieties in the sandy soil of the Veen Colony districts. The latter variety is fast losing its commercial importance owing to the difficulty of growing it on a large scale. For breeding purposes, however, it is very valuable, and in a recent series of hybridization experiments the best product was obtained from a cross between Franschen and Paul Kruger.

With reference to the transmission of the so-called 'degeneration' diseases, the author investigated the possibility of their being transmitted, in the absence of potatoes, from weeds or other plants, by the following experiment which he carried out in 1920.

He divided each of four potato tubers into six parts and planted them in six plots, one part of each potato in each plot, in an enclosed garden containing no other potatoes or Solanaceae. Six of the progeny from these developed leaf roll, and one mosaic. The diseased plants came from different tubers, so that infection very probably did not originate in the seed tuber and was more likely to be due to some external cause. The author considers that the virus probably originated from other plants (not Solanaceous) in the garden.

The importance of early digging of seed tubers, based on the theory that the mosaic virus spreads from the plant to the tuber

[see this *Review*, ii. p. 519] is discussed. With early-ripening varieties this method is quite practicable, but in a late-maturing variety, e. g. Paul Kruger, the tubers are too small for digging in the middle of June (the critical time for infection). Possibly the removal of the foliage would serve the same purpose, since the object of early digging is to sever the connexion between the infected leaves and the tubers. The actual degree of maturity of the tubers at the time of digging is a secondary consideration.

DORST (J. C.). **Aantasting van de Aardappelplant door Rhizoctonia solani en haar bestrijding door sublimaat.** [The infection of the Potato by *Rhizoctonia solani* and its control by corrosive sublimate.]—*Tijdschr. over Plantenziekten*, xxix, 6, pp. 97–106, 1923.

The symptoms and distribution of the *Rhizoctonia* disease of potatoes, caused by *R. solani*, are described. The incidence of the disease in Holland is stated to be very heavy on the varieties Eersteling, Midlothian Early, Schotsche Muis, Geeltjes, Eigenheimer, and Zeeuwsche Blauwe, but whether this is due to the inherent susceptibility of these varieties or to their continual cultivation on infected soil is difficult to determine. The disease is very prevalent in Holland on sandy clay soil and on reclaimed pasture land. A striking feature of the crops grown in the latter type of soil is the tendency to tuber formation above the ground. The application of fresh organic manure appears to increase the incidence of the disease.

The eradication of the causal organism from the soil can only be gradually accomplished by suitable crop rotation, by the removal of weeds and potato refuse, and by seed disinfection. The latter can be thoroughly effected by immersion for one hour and a half in a solution of 1 per cent. corrosive sublimate (0·5 hl. to 1 hl. of potatoes). The temperature of the water used in the solution should not be lower than 5° C. or injuries to the tubers may result. Excellent results have been obtained in Friesland by disinfection with corrosive sublimate, the advantages of which are briefly described.

DE LONG (W. A). **Sulphur and soil acidity.**—*Scient. Agric.*, iii, 10, pp. 354–356, 1923.

It has been definitely shown that the development of potato scab [*Actinomyces scabies*] can be controlled by the application of sulphur to the soil. In order to determine the requirements for optimum results from this method of treatment under Nova Scotia conditions, investigations were undertaken at the Truro Agricultural College on the effects of the application to infested soil of 300, 400, 500, and 600 lb. of sulphur per acre. The sulphur was applied at three different periods, namely, four weeks before, during, and four weeks after planting the potatoes. The inoculated form of sulphur [see this *Review*, i, p. 82] was chiefly used, but for comparative purposes a series of the same amounts of flowers of sulphur applied at the time of planting was included. The experiment recorded in this paper was started in boxes in the greenhouses in January 192., although field experiments are also being carried out. The

soil in the boxes was fertilized at the rate of 500 lb. per acre with a 4-8-4 mixture composed of nitrate of soda, acid phosphate, and muriate of potash. The sulphur applied was thoroughly mixed with the top four inches of soil.

The results of monthly determinations of the lime requirements showed a marked increase of acidity in all cases where sulphur was applied. Up to 500 lb. the amount of acidity produced increased with the quantity of sulphur applied, beyond this amount the results were conflicting, an increase of the lime requirement sometimes being produced and sometimes not. The uninoculated form produced as much acidity as the inoculated. The maximum lime requirement was obtained in every case at the second test, namely, about eight weeks after the planting of the potato setts.

Since the control boxes were treated in all respects similarly to the others, except for the absence of sulphur, it appears reasonable to conclude that the increase of acidity shown by the increased lime requirement was due, directly or indirectly, to the application of the sulphur.

The actual increase in lime requirement was found to be largely in excess of that expected theoretically, even supposing the whole of the sulphur to be oxidized to sulphuric acid. The sulphur may have caused the plants to produce more acid, or there may be some stimulation of the bacterial population of the soil. Of these possibilities the second seems to be the most promising and is supported by the work of others, although further investigation is necessary before the matter can be cleared up.

Rosa (J. T., Jr.). **Spraying Irish Potatoes.**—*Missouri Agric. Exper. Stat. Bull.*, 198, 8 pp., 2 figs., 1923.

Spraying potatoes with Bordeaux mixture has not yet become general in Missouri, probably owing to the relative scarcity of early and late blight [*Alternaria solani* and *Phytophthora infestans*] in the spring and early summer. In other States experiments have shown that proper spraying with Bordeaux generally increases yields even when these diseases are absent.

Experiments with the varieties Early Ohio in 1921, and Irish Cobbler in 1921 and 1922, at Columbia, are described in this paper, which indicate the beneficial action of such sprays in the prevention of tipburn and hopperburn. A serious objection to the spraying of the Early Ohio variety with Bordeaux mixture is the formation of second growths on the tubers [see this *Review*, ii, p. 466]. This objection, however, does not apply in the case of Irish Cobbler. In 1922 spraying this variety four times, when the plants were four to six inches in height, with lead arsenate alone and with Bordeaux plus lead arsenate, gave increased yields of 21·2 and 123·6 per cent., respectively, over the control. Leaf hoppers became abundant at the end of June, and severe burning appeared early in July on the unsprayed plants. The increased yield is probably due almost entirely to tuber growth made by the sprayed plants after the untreated controls have begun to die. Thus by digging comparatively late (August) a considerably larger crop can be obtained from the sprayed plants.

KÖHLER (E.). **Ueber den derzeitigen Stand der Erforschung des Kartoffelkrebses.** [On the present position of research on wart disease of the Potato.]—*Arb. Biol. Reichsanst. für Land- und Forstwirtsch.*, xi, 4, pp. 289-313, 2 pl., 1923.

In this paper the author gives a detailed resumé of the present knowledge regarding wart disease (*Synchytrium endobioticum*), including its distribution, life-history, and symptoms, and incidentally adds the results of his own investigations of this disease. His series of experiments on the development and cytology of the organism, while differing in certain aspects, agreed in the main with those obtained by Miss Curtis [see this *Review*, i, p. 80]. The main points of difference may be summarized as follows. According to the author, the first extrusion of chromatin from the nucleolus into the nuclear cavity of prosoral nuclei is effected solely by means of the linin network, which stains exactly like the nucleolus. The linin network does not become detached from the nucleolus until the extrusion of granules of chromatin into the nuclear cavity has been affected. In the final stages the linin network is visible only as a structure devoid of chromatin (the 'amoeboid body' of Percival), which remains until the division of the primary nucleus, or dissolves and becomes dispersed in the nuclear cavity. Both resting sporangia and prosori were observed to contain 'amoeboid bodies'. In subsequent extrusions the chromatin is exuded drop by drop from the nucleolus and absorbed by the linin network of the nuclear space.

According to Miss Curtis the full complement of nuclei of the prosorus at the time of cleavage and after mitosis has taken place is about 32, but the author observed a considerably larger number. As regards the fate of the chromatin immediately after its extrusion from the nucleus of the resting sporangium the author differs from Miss Curtis. According to him the chromidia extruded into the protoplasm swell owing to the formation of one or more vacuoles which increase considerably in size, and the actual chromidial substance is finally concentrated in a somewhat thin, irregular layer at the periphery of the vacuoles. This layer is ruptured by the progressive increase of the latter and the chromidial mass divided into irregular fragments which are further disintegrated into fine granules and are then distributed in the protoplasm. The fusion of the zoospores was not observed by the author.

In 1922 the author carried out an experiment on the resistant Citrus potato variety, the results of which showed that the degree of infection decreased as the size of the tubers increased. Tubers weighing over 40 gm. were not attacked, and even on the smaller tubers the warts were no larger than a pea, in spite of the presence of numerous summer sori. Further observations on the Adonis variety, on which the warts were also small, indicated that the parasite flourishes independently of abnormal cell division in the affected tissues. It is highly probable that susceptible varieties exert some powerful attraction, the nature of which is obscure, which induces the zoospore to penetrate the epidermis. Conversely, immune varieties appear to owe their freedom from the disease to the absence of this specific attraction.

By means of pure line selection, immune types of the varieties Tannenberg, Wohlgeschmack, and Romaner were obtained.

Further investigations were made on the causes which bring about immunity, but the results were chiefly negative. Dealing first with the colour of the sprouts, the author divided potatoes into the three following groups, according to this character. 1. Those with green sprouts (without anthocyanin). 2. Those with predominantly reddish-purple anthocyanin (denoting an acid reaction of the cell sap). 3. Those with predominantly bluish-purple anthocyanin (denoting an alkaline reaction of the cell sap). There appeared, however, to be no correlation between the potatoes in these various groups and immunity.

It was also ascertained by means of experiments with susceptible, resistant, and immune varieties that there was no connexion between the solanin content of the various organs and susceptibility to, or immunity from, the disease. It was thought that the hydrogen-ion concentration of the epidermal cells might have an important bearing on immunity and susceptibility. In order to test this hypothesis it was necessary to find an indicator which could be absorbed by the living cells. Neutral red was found to be the only colour indicator thus absorbed and it was found that both susceptible and immune varieties took on a similar coloration.

Regarding the control of the disease, the author is of the opinion that the use of immune varieties is the only practical solution, and lists eight German varieties which are immune, as well as various English and American immunes. He summarizes very fully the evidence at present available on the attempts at sterilizing soil infected with the parasite.

There are numerous references to the work of previous investigators and a bibliography is appended.

Schander & Richter. **Ueber den Nachweis von Dauersporen von Chrysophlyctis endobiotica Schilb. (Kartoffelkrebs) in der den Kartoffeln anhaftenden Erde.** [The detection of resting spores of *Chrysophlyctis endobiotica* Schilb. (Potato wart disease) in the soil adhering to Potatoes.]—*Centralbl. für Bakt.*, Ab. 2, lviii, 19–24, pp. 454–461, 1923.

The increasing prevalence of wart disease of potatoes, caused by the fungus *Chrysophlyctis endobiotica* [*Synchytrium endobioticum*], in Germany necessitates the immediate introduction of a method whereby the soil particles adhering to potato consignments can be rapidly and thoroughly inspected for the presence of the causal organism.

The results of a preliminary series of experiments showed that direct microscopical examination of the soil was not a reliable method when the proportion of soil to diseased tissue from the excrescences was 100 to 1, since spores were easily concealed by the larger particles. The possibility that the specific weight of the spores might be less than that of soil particles of the same size suggested that if spores and soil particles were mixed with water and stirred, the latter would sink and form a deposit at the bottom of the tube while the spores floated. This proved to be the case in a series of tests in which 10 gm. of soil, containing 600 to

1,000 spores per gm., were placed in a tube with five times the amount of water, the proportion of soil to diseased tissue being 100 to 1. After one minute the coarser soil particles had settled and the liquid above was decanted into a second tube, where it was left standing for five minutes. Microscopical examination of the sediment in the second tube revealed the presence of resting spores. The latter were also present in the liquid after 24 hours' standing; they were extracted by centrifuging and added to those in the sediment. This was then mixed with a little water and examined under the microscope; it was found that one drop contained 10 to 15 spores, which, surrounded by minute soil particles and cell remains, were easily recognizable. The results of further tests showed that this method was still reliable when the proportion of soil to diseased tissue was 2,000 to 1. At this ratio there are 300 to 500 spores of the fungus per kg. of soil, corresponding to 0·5 gm. or 0·5 cc. of warty tissue.

Suggestions are made regarding the practical application of this method to the inspection of potato consignments transported by rail or sea. Not only should the potatoes be superficially inspected in the vans but a microscopical examination should also be made if possible from the soil fallen on the floor of the wagons. In doubtful cases about 50 tubers should be removed to the laboratory for closer inspection on the lines described above. Should the decay of the tuber be due to *Phytophthora* the consignment may be released, but if there is any trace of wart disease the potatoes must be taken to the nearest distillery or starch factory [see this *Review*, ii, p. 336]. Attention is drawn to the danger of using vans which have been occupied by infected potatoes for the transport of agricultural implements, live stock, hides, and the like, to which the spores of the fungus may easily adhere. Such vans should be disinfected with a 3 per cent. solution of cresol sulphuric acid and the infected soil and other refuse burnt, buried, or mixed with a disinfectant.

PETCH (T.). **A root disease of Hevea (Xylaria thwaitesii Cooke.)**—*Trop. Agric.*, lx, 2, pp. 100–101, 3 pl., 1923.

In 1921 and 1922 mature *Hevea* trees were found to be suffering from a root disease, apparently caused by a *Xylaria*, which had previously been recorded only once, in 1910.

On the affected roots the fungus forms black, flat, irregular bands, sometimes in a network, and extensive patches or plates. The bands, which appear to result from the fusion of small patches into a continuous line, are smooth, sometimes longitudinally ridged, and white internally. They generally exceed 2 mm. in width and are less than 1 mm. in thickness. A root may be partly covered with a network of these bands through which the pale cortex is visible, whilst the remainder is concealed under a continuous black sheet.

In the early stages of the disease the wood of the roots does not show any very marked symptoms. In advanced stages, however, the characteristic features of the disease, which are quite distinct from those of any other root disease of *Hevea*, are readily recognizable. When the root is split longitudinally the central region is

moist, but still hard, and dark brownish-grey in colour. Outside this region the wood is drier and yellow-brown in colour, a black line sometimes separating the two zones. Black lines and ovals may be present, but are not a constant feature of the disease, as in *Ustulina*. The hardness of the discoloured wood is noteworthy. The inner tissues of the cortex become brown and friable, being broken down sometimes into fragments united by fine strands of rubber, but the external layer does not show much alteration.

The fructifications generally appear on the ground near a lateral root or the collar of the tree. They occur in clusters, arising from a basal mass in the soil or at ground level. In some cases three or four stout stalks arise from the basal mass and divide above into numerous fructifications; in other cases the fructifications all arise from the same level. They are very variable in shape, up to four inches in height and one inch in breadth, and have a light brown outer layer which usually disappears as they mature, leaving a black surface. They are somewhat corky and white internally.

The appearance of the fructification coincides approximately with the death of the tree. In all material hitherto found, the fungus has not been mature, since the infected trees have naturally not been allowed to remain until the fungus matured. The spores and perithecia of the fungus are rarely developed in the laboratory, but in one case this was successfully accomplished, leaving no doubt that the organism was a *Xylaria*.

In the first record of this disease the species was referred to as *X. zeylanica*, but it would appear from an examination of the type specimens of Ceylon species of *Xylaria* in the Kew Herbarium that its correct name is *X. thwaitesii*.

RINGOET. **La culture de L'Hévéa à la Station agricole de Yangambi-Gazi (Province orientale) durant l'exercice 1921.** [The cultivation of *Hevea* at the agricultural Station of Yangambi-Gazi (eastern Province) during 1921.]—*Bull. Agric. Congo Belge*, xiv, 1, pp. 8–9, 1923.

Thread disease or streepjeskanker [*Phytophthora*] and mouldy-rot [*Sphaeronema fimbriatum*] of *Hevea* rubber, of which the first named is more common, are very often found in association. The damage done in the East Indies by these diseases is considerable, but in the Belgian Congo the dry climate does not encourage their development, and cases are not of frequent occurrence. Regular applications of 5 per cent. agrisol or brunolinum plantarium solutions are made, and affected trees are given a rest.

Brown bast, though not unknown, has not assumed disquieting proportions in the Belgian Congo. At the Station, out of a total of 2,342 trees, 344 or 14·7 per cent. are more or less affected. No treatment has so far been applied, but trees yielding little or no latex are given a rest. It is hoped to make a trial with hot tar, which has been successful in Java.

Root diseases are also reported, but have not, as yet, been identified.

STEVENS (H. P.). **Effect of mould on a sheet Rubber compounded with litharge.**—*Bull. Rubber Growers' Assoc.*, v, 6, pp. 341–342, 1923.

A slight retardation in the rate of cure is always noted with sodium silicofluoride prepared rubber when vulcanizing an ordinary 90–10 test mixing of rubber and sulphur [see this *Review*, ii, p. 139]. When the minimal proportion of sodium silicofluoride is used, namely, 1 in 2,000 of latex, the retardation may not exceed 5 per cent., but with larger proportions it may amount to 10 or 15 per cent.

Vulcanizing tests, using the ordinary rubber sulphur 90–10 mixing and the same with the addition of 50 parts of litharge, have been made with samples of rubber (1) coagulated with acetic acid and (2) coagulated with sodium silicofluoride (1 lb. to 150 galls., i. e. 1 in 1,500), soaked for half an hour in a saturation of sodium silicofluoride, drip dried, and smoked as usual. The samples were packed in a case exposed to rain for one night. On unpacking the case a fortnight later the acetic acid coagulated sheet was found to be covered with mould, whereas the sample coagulated with and soaked in sodium silicofluoride was clean.

Tests of the two samples, compounded in one case with sulphur only and in the second with litharge, showed that in the former case the acetic acid control cured more rapidly than the sodium silicofluoride prepared rubber, while with the addition of litharge the reverse was the case. In the case of the litharged samples the mouldy condition of the acetic acid prepared sheets probably accounts for the low rate of cure as compared with that of the sodium silicofluoride sheets. This reversion in the order of the rate of cure by the addition of litharge demonstrates the importance of its inclusion in the tests until a final decision as to the comparative merits of acetic acid and sodium silicofluoride as coagulants is reached.

NORTH (D. S.). **The control of Sugar-cane diseases.**—Reprinted from *Australian Sugar Journ.*, xiv and xv, 46 pp., 1923.

This paper is stated to be the first of a series which will embody the results of investigations on sugar-cane diseases in Australia made since 1907, and also of field measures commenced in 1919 with a view to controlling these diseases on lines similar to those which in Fiji are claimed to have secured such effective control of 'Fiji disease' [see this *Review*, i, p. 187, and ii, p. 288] and other sugar-cane diseases that they have caused no serious losses in the crops of that Island of recent years.

In an interesting discussion of the means by which sugar-cane diseases have reached Australia and Fiji, the author [who is pathologist to the Colonial Sugar Refining Co.] takes both countries together, since the free interchange of varieties between them [the Company having large interests in both areas] has led to their varieties and diseases being practically identical. Nevertheless, though certain diseases have undoubtedly been introduced with interchange of varieties into particular areas, they have not always succeeded in becoming permanently established there. Fiji disease, for instance, has never become established at any of the Company's

mills in Queensland, though it has been long prevalent and highly destructive in New South Wales and Fiji: while *Sclerospora sacchari* has not been found in New South Wales, though it occurs throughout Northern Queensland and Fiji.

The author thinks that Australia has a longer list of serious cane maladies than any other country, having been more active than most in introducing new varieties and their diseases from all over the world. None of the diseases hitherto found is regarded as endemic, New Guinea, from which many varieties have come, being considered the home of those Australian diseases of which the origin has hitherto been obscure. There is stated to be definite evidence that this is the case with Fiji disease, while *Sclerospora sacchari* and the hitherto undescribed 'leaf scald' (*Bacterium* sp.) are also suspected to have come from the same source. Little is known of the sugar-cane diseases of New Guinea, and importations from that island are held to be exceedingly dangerous.

Much success has attended the efforts to control diseases by the use of resistant varieties, but the latter appear to have been introduced without due care so that they brought new diseases with them: each variety was sooner or later attacked in its turn, either by a new disease or an old one resuscitated. No universally resistant variety has hitherto been discovered; Badila appears to be the nearest approach to a generally resistant cane, but has been badly damaged by Fiji disease and gumming in certain areas. Furthermore, the use of resistant canes has often entailed a sacrifice of yield and quality. Hence the author believes that other methods of disease control are urgently required in Australia, and he advocates those that have been tested and found effective in Fiji. Each disease requires a different treatment, but they may be grouped to some extent by their salient characters.

The five most virulent cane diseases of Australia constitute a group characterized by the fact that a diseased cutting will always produce a diseased plant. They are gumming (*Bacterium vascularum* (Cobb) Greig-Smith), leaf scald (*Bacterium* sp.), leaf stripe [downy mildew] (*Sclerospora sacchari* Miy.), Fiji disease [*Northiella sacchari* Lyon (*Phytamoeba sacchari* McWhorter)], and mosaic disease. Each of these diseases is also highly infectious by some aerial (not, so far as is known, soil-borne) means of spread to other canes in the vicinity. Each is caused by a strict parasite, unable to thrive for long apart from its living host. Each is 'incurable', that is, the infected plant is permanently diseased. The main source of infection is undoubtedly the use of diseased stools for 'seed'. For this group effective control is to be sought in the measures of field sanitation outlined by the author. The first of these is 'seed' selection, the aim being to avoid the planting of diseased setts. With gumming and leaf scald, no field in which infection may reasonably be suspected should be used for seed. For success in seed selection an exact knowledge of the symptoms is required, and much use has also been made of the known factors which influence the occurrence of these diseases, such as the prevalence of Fiji disease on rich land, of leaf stripe on poor, of gumming in badly drained areas, of leaf scald on higher, dry land, and of mosaic in hilly country. The second measure required is

the removal of sources of infection by ploughing out badly diseased fields after harvest and by eradicating all the diseased stools in milder cases. In widespread outbreaks, as when all the fields of a farm have become severely infected, such drastic measures are impracticable, and slower methods, such as the introduction of resistant varieties as an adjunct to seed selection and eradication, must be adopted. Other measures, applicable to certain diseases only, are desirable. Such are the avoidance of knife infection with gumming and leaf scald, improved drainage and cultivation, and the like.

In a second group are included red rot (*Colletotrichum falcatum* Went), root disease of the type said to be caused by species of *Marasmius*, and the sclerotial disease of the leaf sheath. Top rot [see next abstract], rind disease (*Melanconium sacchari* Massee), and pineapple disease (*Thielaviopsis paradoxa* (de Seynes) v. Höhnel) may, perhaps, be added to this group, though the two last apparently only attack parts already dying or dead from other causes. These are all considered to be due to weak facultative parasites, capable of persisting on rotten cane or in the soil for long periods. In soil so contaminated, cane may be severely attacked under unfavourable conditions for its growth, such as during periods of drought or floods. These diseases are not incurable in the sense used above, for a healthy plant may sometimes develop from an infected sett. With them seed selection and the eradication of diseased plants are measures of secondary value; the reduction of soil infection by crop rotation, and the use of resistant varieties are more important, while good cultivation, manuring, and drainage will also help by promoting a thrifty, even growth.

In the third group a great variety of leaf spots, such as true rust [*Puccinia kuehnii* (Krueger) Butler], eye spot (*Cercospora sacchari* van Breda) [? *Helminthosporium sacchari* Butler], and ring spot (*Leptosphaeria sacchari* van Breda), are included. The majority of these, though conspicuous, are not usually sufficiently harmful to warrant special control measures. They mostly appear at a particular season, such as winter, and disappear later on without seriously affecting the cane. Occasionally, however, particular varieties have been badly damaged or even killed by certain of these diseases, and new varieties have had to be substituted.

Apart from field control, stringent precautions against the distribution of diseases with cane plants sent from one area to another are required. The safeguards suggested are: (1) strict attention at the forwarding end to ensure that only perfectly healthy plants are sent: (2) planting in quarantine under careful supervision by a plant pathologist, on receipt, until freedom from diseases and pests can be guaranteed; (3) raising new varieties at several different centres within the country from seed, instead of obtaining them from abroad. Within a particular mill district, bulk distribution of plants is sometimes necessary to replace diseased crops, but this should be carefully controlled by technical supervision. Foreign importations should be limited to a few varieties of outstanding promise at long intervals, and a quarantine of two years should be imposed not only in such cases but usually

when plants are sent from state to state within Australia, or even from one mill district to another unless adjoining and with similar varieties and diseases. The essentials of an effective system of quarantining are discussed at some length.

The necessity for such rigid precautions is chiefly due to the fact that it is impossible to guarantee freedom from disease at the forwarding end. It has been proved in the case of leaf stripe, Fiji disease, gumming, and leaf scald that the disease may remain latent in the growing cane for a long time with no symptoms that can be detected. Concrete cases in support of this statement are quoted. Mosaic disease was also widely disseminated with cane importations before its symptoms were recognized.

The raising of seedling canes in Australia, where little of this nature has hitherto been effected, is discussed and also the testing of varieties, special emphasis being laid on the common experience that diseases are far more prevalent in variety blocks than elsewhere, and that experiment stations engaged in variety-testing are very liable to disseminate diseases. The growing by farmers of a number of varieties instead of one or two standard canes is deprecated.

An interesting account is given of the application of the above considerations to farm practice in the Richmond River district of New South Wales. Every farm is periodically visited for the purpose of assisting the farmer in the selection of his seed and the recognition of diseases present in his crop. Advice is given regarding suitable varieties to be grown and, when required, on all matters of cultivation, drainage, and the like, as affecting disease control. A history of each field is recorded in field plan books which comprises area, variety, source of seed, incidence of diseases, and cultivation data. From this information the progress of diseases from year to year can be followed and steps taken to renew the stock from safe areas when required. Plot trials are laid out on a number of farms, planting, weighing, and the like being controlled by the Company's scientific staff, and much information as to the resistance of disease of different varieties is thus being obtained.

Mosaic and Fiji diseases are proving fairly easy to control by these measures, but gumming and leaf scald have given trouble for various reasons which delayed the taking of effective measures. Accurate estimates of the losses from these four diseases in one mill district gave over 9 per cent. in each of the years 1920 and 1921, estimated on the cane tonnage.

TRYON (H.). **Top rot of the Sugar-cane. An inquiry into the nature and origin of a disease affecting Sugar-cane in the Herbert River and other districts of Queensland.**—*Queensland Bureau of Sugar Experiment Stations. Divn. of Path. Bull.* i, 56 pp., 9 pl., 1923.

The author states that this memoir was written in 1905 but has not previously been printed, though a summary of it appeared in the *Queensland Agric. Journ.*, xxi, pp. 498–505, 1906. The work on which it is based was carried out in 1903, but the disease appears to have been recorded many years earlier and to have caused losses in Queensland as far back as 1891.

The first external symptom is etiolation of the central shoot of unexpanded leaves, whose tips become, at the same time, dry, somewhat drooping, and brownish-green. Two or three of the expanded leaves nearest this shoot show similar changes, and a brown or reddish streak on each side of the midrib may also be found on them. Later on the central shoot dies and the expanded leaves gradually become more and more affected, until all are withered. As this occurs the shoot itself rots at its base and may fall over or be easily pulled out from the top of the cane. The leaf sheaths belonging to the internal leaves show progressively greater destructive changes as the centre of the apical bud is approached, when exposed by stripping. These changes are greatest at the insertion of the sheath on the stem node, and are always more severe than the changes in the corresponding leaf blades would suggest. The inner sheaths may be completely rotted, those next outside show dark purplish areas extending upward from the base and surrounded by red markings, while those farther out have only red bands, or lines, continuous at the base but broken into spots or blotches, suggestive of splashings from a paint brush, higher up. The apical part of the stem is found, on stripping away all the leaf sheaths, to have markings in continuation of those on the sheaths, at first reddish-brown, then brown and collapsed. These markings extend down from the node into the internode below, and evidently originate in anterior changes in the leaf sheaths.

On sectioning an affected shoot in the earliest stages, before any external symptoms are visible, the innermost white leaves, just above the apical point of the stem and wholly enclosed within the bud, show a purple or brown discoloration on each side of the midrib. Later on this discoloration reaches the stem through the nodes on which the affected leaves are inserted, these being usually a short distance behind the still intact growing point. The upper affected internodes of the stem become soft at the same time as the inner portion of the central leafy shoot rots, while four or five of the next lower internodes show browning of the stem tissues with here and there a red fibre, especially at the nodes. The outer tissues of the stem, immediately below the nodes, are more deeply discoloured than those farther in, corresponding with the brown markings in the epidermis already mentioned. In the lower part of the affected portion of the stem, only the nodes may be discoloured. Sometimes even at this stage of the disease, the apex of the stem completely rots away, leaving a cavity filled with moist brown fragments of disintegrated tissue. This complete rotting of the stem apex normally occurs, however, somewhat later in the course of the attack, and forms a cavity bounded by the bases of the leaf sheaths, and containing a strongly smelling mass of decayed tissue. Longitudinal fissures may penetrate the softer tissues still farther down, and at times nothing but the rind and bundles is left in the internodes. The decay may progress down to the base of the cane or be arrested at some point higher up. The discoloration referred to above, both in the inner sheaths and in the tissues of the stem, originates, according to the author, in the phloem of the vascular bundles. There is no gum flux in the affected tissues.

Quite similar changes, allowing for the differences in size and differentiation, may be found in the tiller-buds below soil level, especially after ratooning. These may be rotted even when still surrounded by a normal bud sheath.

At the same time that the main shoot is checked in growth by the onset of top rot, the dormant buds at many of the nodes lower down commence to sprout. In many cases these shoots develop into canes. Sometimes the apical point of the main shoot escapes damage until such time as the disease lower down is checked; it then continues to grow and a normal cane may be produced except for certain markings in the leaves or in a few nodes. Unless the growing point becomes involved, recovery takes place.

The attack develops irregularly in the cane stool, often affecting only some of the shoots and these not necessarily in the order of their development, though the primary shoots are most commonly the first to be attacked.

The varieties most affected were Rappoe (Rose Bamboo), the chief cane cultivated on the Herbert River, and Striped Singapore. Meerah and white Bamboo (Louzier) were also susceptible. No disease was seen in Lahaina, Violet, or Cheribon.

Top rot is usually most virulent in March in cane nine or ten months old, but can attack much younger plants. There is no evidence that it arises from the use of diseased cuttings for planting, and seed selection does not appear to be a satisfactory method of control. Cuttings from diseased stools may produce healthy plants, and in some cases diseased plant cane appears to have given a healthy ratoon crop. There is some evidence of spread to adjacent plants in the field, and also, though less satisfactory, of persistence of the infection in the soil of certain areas. Soil conditions do not greatly affect its incidence, though it was more common on sandy soils; virgin soils are not immune, while rich manuring appears to have favoured the disease. Low-lying areas were most commonly affected in 1903. The author believes that a low rainfall during the early part of the growing period of the crop (May to October), followed by excessive rain in January, predisposes to attack.

No organism to which the disease could be attributed was found in the innermost sheaths of the apical bud—the first to show symptoms of attack. Later on secondary organisms, fungi and bacteria, attack the disorganized tissues and cause the foul-smelling wet rot already mentioned. The author believes that the early symptoms found at the tip of the shoot result from chemical changes induced by a pathological condition of the roots of affected plants. The lateral roots were found to be softened and decayed from the tip back towards the main roots, and the latter were more or less decayed in their turn. In the early stages of this decay the normal white colour is replaced by a purple tinge. Cases were seen in which the decay had been arrested and new healthy roots had developed. This corresponded with recovery of the diseased shoots.

The root decay is believed to be due to the attack of a parasitic fungus, which is briefly described and figured, but not named. It

is suggested that it is possibly identical with an organism found by Kamerling occasionally in the 'Wortelrot' disease of sugar-cane in Java. Various other organisms were found in the affected roots, but no inoculation experiments with pure cultures appear to have been carried out with any of them.

Treatment is not discussed, except for the suggestion that the growing of resistant varieties may lead to control of the disease. Early planted cane is stated to escape injury from top rot in many cases.

Coert (J. H.). **Wortelrot in EK 28 in Kediri.** [Root rot in EK 28 in Kediri.]—*Meded. Proefstat. Java Suikerind.* 7, pp. 291–307, 1923.

The results of recent experiments on the effect of different periods of rotation on the control of root rot in the sugar-cane variety EK 28 [see this *Review*, ii, p. 526] showed that this trouble was more prevalent in biennial than in triennial crop rotation (10·42 as against 3·42 per cent.) The extreme limit of the period of non-occupation of the land by cane in biennial rotation is 17½ months as compared with 29½ months in triennial rotation. With late maturing varieties, however, the period of non-occupation in triennial rotation is only 18 months, this approximating closely to the extreme limit in biennial rotation. The probability of root rot is therefore greater in EK 28 when grown after late maturing varieties, such as DI 52. Hence also the liability of EK 28, itself a late ripening variety, to root rot when grown for many years in succession on the same ground. In one experiment the percentage of root rot in EK 28 immediately following the same variety was 7·17, as compared with 3·13 after other varieties.

Under Kediri conditions the incidence of root rot in EK 28 on red laterite soils is very slight.

Brandes (E. W.) & Klaphaak (P. J.). **Cultivated and wild hosts of Sugar-cane or Grass mosaic.**—*Journ. Agric. Res.*, xxiv, 3, pp. 247–261, 4 pl., 1923.

The results of inoculation experiments, the technique of which is described, carried out from 1919 to 1921 on over forty species of cultivated and wild grasses proved the following thirteen to be susceptible to the disease known as sugar-cane mosaic, but which should be more properly termed grass mosaic: sugar-cane (*Saccharum officinarum*), maize (*Zea mays*), sorghum (*Holcus sorghum*), pearl millet (*Pennisetum glaucum*), eulalia (*Miscanthus sinensis*), wild sugar-cane (*Saccharum narenga*), bull grass (*Paspalum boscianum*), crab grass (*Syntherisma sanguinalis*), yellow and giant foxtail (*Chaetochloa lutescens* and *C. magna*), barn-yard grass (*Echinochloa crusgalli*), *Panicum dichotomiflorum*, and *Brachiaria platyphylla*.

The virus was artificially transmitted in one series of inoculations, one half to two ccs. of cell sap (obtained by squeezing young stalks in a powerful press under mineral oil) being injected near the growing point by Leur all-glass hypodermic syringes. In one instance the virus was passed through a rather coarse Berkefeld filter, but was still virulent in 75 per cent. of cases. In other experiments the virus was shaken with various disinfectants before injection,

none of the inoculations being successful except on one plant in a series of four in which the virus was treated with phenol. Virulent virus, kept for 24 hours, was found to be unable to cause the disease.

From these experiments it appears that the virus of grass mosaic is less stable than that of other similar diseases, notably tobacco mosaic. It loses much of its virulence during manipulation or chemical treatment.

The insects used in the insect transmission series of experiments were *Aphis maidis*, *Kolla similis*, and *Draeculacephala mollipes*, only the first of which was proved to act as a carrier of mosaic.

Certain varieties of sugar-cane belonging to the slender North Indian type (which includes Uba, Kavangire, and others) formerly regarded as immune, were found to be susceptible to mosaic, but the disease attacked them in such a mild form as to be scarcely noticeable.

In the course of the experiments a method of transferring aphids from one plant to another was developed by which small bits of infected leaves covered with aphids were clipped off and tied to healthy plants. Controls (*a*) with similar infected portions with the aphids removed and (*b*) with healthy leaves covered with non-virulent aphids were necessary.

The result of tests in Southern Georgia for resistance to mosaic of forty varieties of maize planted in close proximity to infected Louisiana Purple sugar-cane plants showed that of the twenty-three infected, the northern and western varieties were much less liable to attack than the southern ones. This is believed to be due to the subnormal development of the former. which frequently induces resistance to experimental infection, rather than to any inherent immunity. It was shown by data on the yield of seventeen varieties of southern field maize that mosaic caused a reduction in weight ranging from 0·4 to 50·6 per cent.

Field observations in Georgia indicate that natural infection of sorghum (especially the Honey and Sugar Drip varieties), pearl millet, crab grass, bull grass, giant foxtail, and *Brachiaria* is widespread near affected cane in the sugar-cane belt.

The results of experiments to determine the possibility of seed transmission of mosaic were negative. This supports the conclusions of various authorities in Java, who found that sugar-cane seedlings from mosaic parents remain healthy unless infected from external sources. It appears, therefore, that the virus is not transmissible by the seed.

RAGUNATHAN (C.). **The occurrence of teleutospores in Hemileia vastatrix B. & Br.**—*Trop. Agric.*, lx, 2, p. 128, 1923.

In order to obtain information on the occurrence of teleutospores of *Hemileia vastatrix* in Ceylon, periodic observations of *Coffea arabica*, *C. robusta* and *C. liberica* were made at Peradeniya between May 1921 and April 1922. Teleutospores were found in every month except August and October 1921 and April 1922, their absence presumably being due to the development of new foliage in August and April and to the heavy rains in October. No definite statement can be made regarding the reasons for the

occurrence of the teleutospores except that it is dependent on climatic conditions.

On 1st February 1922 a single teleutospore of *Hemileia canthii* was observed on *Canthium campanulatum*. This had produced a promycelium in the sorus. The teleutospore was much smaller, and the promycelium more slender and brighter in colour, than in *H. vastatrix*.

Ito (S.). **Uromyces of Japan.**—*Journ. Coll. Agric., Hokkaido Imp. Univ. (Sapporo, Japan)* xi, 4, pp. 211–287, 3 pl., 1922. [Rec'd 1923].

The author gives a complete list of the species of *Uromyces* and *Pileolaria* recognized in the Japanese flora, fifty-six of the former genus, and three of the latter. Nineteen are endemics, twenty-three occur also in America, and twenty-three in Europe. There are eight new records for Japan, nine species, before recorded, are excluded from the flora, six are now recognized as synonyms, and three do not belong to these genera at all. The single new species *U. viciae-unijugae* is allied to *U. heimerlianus* P. Magn., but is distinguished by the thicker wall of both the uredo- and teleutospores. The species are arranged according to the natural orders of their host plants, and where required, a key is given for the species occurring in each order. Under each species are given all references to its literature, a full synonymy, localities with dates and collectors' names, and its world distribution. The work closes with a list of the accepted fungi and a host index.

Mayor (E.). **Étude expérimentale d'Urédinées hétéroïques.** [Experimental investigation of heteroecious Uredineae.]—*Bull. Soc. Neuchâtel. Sci. Nat.*, pp. 67–78, 1923.

The first part of this paper deals with *Hyalospora polypodii-dryopteridis* (Moug. & Nestl.) P. Magnus, the uredo- and teleuto-spore stages of which occur on *Dryopteris linnaeana* and *D. robertiana* respectively. This fungus is very widely distributed throughout Europe and has also been reported from the United States. Its life-history, however, was hitherto incompletely known as the host of the pycnidial and aecidial stages had not been discovered.

In June 1919, at Perreux [Saône-et-Loire] the author observed aecidia on the three-year-old needles of *Abies pectinata* seedlings growing among ferns which in the previous year had been severely infected by *H. polypodii-dryopteridis*. Subsequent observations showed that the pycnidia of the fungus developed only on two-year-old needles and the aecidia on three-year-old ones. In May 1920, teleutospores were collected on *D. linnaeana* growing near the *Abies* affected in 1919. Four seedlings of *A. pectinata* were inoculated with these teleutospores the same day and developed the typical symptoms of infection in April 1921, numerous pycnidia being present on the needles. Repeated attempts to secure the development of aecidia gave negative results.

In May 1922 aecidia were collected on *Abies pectinata* growing on the site mentioned above and inoculated into very young fronds of *D. linnaeana* and *D. robertiana*. Those of the latter withered almost immediately, while *D. linnaeana* remained healthy until

June, when the first uredospores appeared. The teleutospores developed in the spring of 1923. The fungus therefore requires a minimum period of four years to complete its life-cycle. The pycnidia and aecidia of *H. polypodii-dryopteridis* are very inconspicuous, and infection never takes place on a large scale, which accounts for these stages having been so long overlooked.

FLEROFF (B. K.). К цитологии **Ustilago avenae Pers.** по данным культуры **in vitro.** [Contribution to the cytology of *Ustilago avenae* Pers. based on cultures *in vitro*].—*Trans. Myc. & Phyto-path. Sec. Russian Bot. Soc.*, I, *Trans. Moscow Branch*, pp. 23–36, 1 pl., 1923.

After a brief review of the work done by other investigators in the study of the Ustilaginaceae, the author describes his culture experiments *in vitro* by which he established the existence of two races of *Ustilago avenae* differing from each other in the germination of their spores. Both races were collected on unnamed species of cultivated oats, the first in the province of Vladimir, and the second in the vicinity of Moscow.

In water and weak nutritive media the spores of both races produced promycelia with typical clamp-connexions and a small number of sporidia, which fused together (conjugated) and gave rise to a mycelium, but in a more concentrated medium (gelatine 8 per cent., KH_2PO_4 0·05 per cent., $MgSO_4$ 0·02 per cent., glucose 5 per cent., Liebig's extract 1 per cent.) the differences were clearly apparent. The germinating spores of race 1 produced a large number of conidia which were never seen to fuse together or to give rise to mycelium; in a few days the whole surface of the agar was covered with comparatively large colonies of budding conidia. On transferring such colonies into a liquid medium (the formula of which is given) the fungus continued its budding. After 6 to 7 days the conidia began to increase in size, became rounded and finally formed chlamydospores, which germinated on attaining maturity. These chlamydospores differed from those produced in nature by their thicker walls and by their larger size (some being about twice as large). The mycelium of race 1, produced in a weak nutritive medium as described above and then transferred to a more concentrated one, immediately began to produce sporidia which multiplied by budding and never fused together. Race 2, however, on the same concentrated medium and under similar conditions, produces conidia which after 4 to 5 days give rise to a mycelium. The same occurs in a liquid medium, the growth of the mycelium being like that ordinarily found in smuts. About a fortnight after their development in the liquid medium, the unicellular hyphae start to branch after developing transverse septa, while a few of them begin to swell and to break up into separate cells, with thickened, brown walls, which are finally transformed into spores. The formation of spores is, however, considerably less abundant than in race 1, and they much more resemble the natural spores both by their size and the structure of their walls. In germinating these spores produce a promycelium with typical clamp-connexions.

With regard to the cytology of *U. avenae* the author determined that the spores of this fungus obtained *in vitro* are formed from a

uninucleate cell without any preliminary nuclear fusion, and that the mycelium on which the spores are borne is uninucleate throughout all the stages of its development. On the other hand a binucleate mycelium develops in those cases in which there is either a fusion of two cells of the promycelium or of two conidia, and a similar condition may arise at times by the simple division of the nucleus, in a conidium developing into mycelium. The reduced type of sexuality already known to exist in the smuts can thus, he points out, be still further reduced in culture.

SMITH (J. H.). **On the apical growth of fungal hyphae.**—*Ann. of Bot.*, xxxvii, 146, pp. 341-343, 1923.

An account is given of detailed observations regarding the growth of fungal hyphae, the tests being undertaken by the author in order to check the generally accepted statement in text-books that the growth of hyphae is apical. The fungi tested were species of *Phytophthora, Aspergillus, Penicillium, Pyronema, Rhizoctonia, Rhizopus, Botrytis,* and *Fusarium*. Spores, or fragments of mycelium were sown on clear prune agar poured on cover-slips, which were then inverted over Van Tieghem cells and the preparations incubated at 24° to 25° C. After germination, when the hyphae had reached a convenient size, the lengths of the segments already formed were measured, at varying intervals of time, over a period of from five to fifty-six hours. Where septa were absent or difficult to distinguish, the intervals between successive branches were determined.

The experiments have demonstrated that growth takes place at the tip and that no appreciable elongation occurs in any other part of the hypha. In view of the wide range of genera tested, this would appear to be the general rule for fungi and may be contrasted with the growth of filamentous bacteria, in which each of the segments expands at the same rate, and of algae, in which both apical and intercalary growth occurs.

BEELI (M.). **Énumération des champignons signalés au Congo Belge.** [List of fungi recorded in the Belgian Congo.]—*Bull. Jard. Bot. de l'État (Bruxelles)*, viii, 1 pp. 67-101, 1923.

The mycological flora of the Belgian Congo is still very little known. So far only 593 species have been recorded, distributed among about 326 genera and 42 families. The author, in this paper, after a short introduction, gives a list of all records of Belgian Congo fungi, arranged according to their orders; the reference to the work in which each species was first described and the reference in Saccardo's *Sylloge* are supplied in each case. The habitat is noted in many instances, and those species represented in the Congo Herbarium in Brussels are indicated.

DA CAMARA (E. de S.). **Minutissimum mycoflorae subsidium Sancti Thomensis Insulae. I. Mycetes.** [A small contribution to the fungus flora of St. Thomas Island. I. Mycetes.]. Reprinted from *Anais do Inst. de Agron.*, 3 pp., 2 pl., Coimbra, 1923.

Eight species of microfungi are recorded, of which two are new, namely, *Calospora theobromae*, in the cortex of *Theobroma cacao,*

which differs principally from *C. bahiensis* Speg., in its smaller ascospores (35 to 45 by 7·5 to 10 μ) and in its asci always containing 8 spores, and *Macrophoma nicotianae* found on the stems of *Nicotiana tabacum*.

COUTINHO (A. X. P.). **Florae mycologicae Insulae St. Thomae (Sinu Guineensi) contributio.** [Contribution to the mycological flora of the Island of St. Thomas (Gulf of Guinea).] Reprinted from *Anais do Inst. de Agron.*, 26 pp., 3 pl., Coimbra, 1922.

This paper gives a list of 76 fungi (of which 74 are Basidiomycetes) collected by the author in the island of St. Thomas during 1920 while he was engaged in pathological work. References to the literature, the hosts, localities, and a short Latin description are appended to each species. The author describes and figures ten new species, of which three are wood-inhabiting Polypores.

The following Polyporaceae are recorded: on *Theobroma cacao*; *Poria ferruginosa*, *Fomes pectinatus*, *Polyporus zonalis*, *Trametes gibbosa*, *T. sprucei*, ? *T. sepium* (Rav.) Berk., and *T. sanguineum*: on *Cocos nucifera*; *Fomes ochrolaccatus*, *F. multiplicatus*, *F. applanatus*, *Polystictus occidentalis*, *P. sanguineus*, and *Trametes ohiensis*: and on *Elaeis guineensis*; *Fomes applanatus* and *F. senex*.

Fruit and Vegetable Quarantine, Notice of Quarantine No. 56, with Regulations.—*U.S. Dept. of Agric. Fed. Hort. Board*, August 1923.

Under this quarantine order, coming into effect on 1st November 1923, and framed with the purpose of preventing the introduction into the United States of certain injurious insects, including fruit and melon flies (*Trypetidae*), the importation into the United States is forbidden of fresh fruits and vegetables (i.e. the edible, more or less succulent, portions of food plants in the raw or unprocessed state, such as bananas, oranges, grapefruit, pineapples, tomatoes, peppers, lettuce, &c.) from abroad and of plants or portions of plants (i.e. leaves, twigs, or other portions of plants, or plant litter or rubbish as distinguished from clean fruits and vegetables or other commercial articles) used as packing materials in connexion with shipments of such fruits and vegetables, the whole subject to the exceptions mentioned below. All special quarantines and other orders hitherto in force restricting the entry of fruits and vegetables remain in full effect, with the exception of Quarantine No. 49 with regulations, on account of the citrus black fly, which is superseded by this Quarantine.

The following is a compendium of the most important regulations appended to the order:

All importation of fruit and vegetables must be free from plants or portions of plants, as defined above. Dried, cured, or processed fruits and vegetables, including dried products, cured figs, dates, and raisins, &c., nuts, and dry beans, peas, &c., may be imported without permit or other compliance with these regulations. Subject to the restrictions now in force or which may hereafter be promulgated as to certain countries and districts, the following fruits may be imported from all countries under permit and on compliance

with these regulations: bananas, pineapples, lemons, sour limes, and grapes of the European or *Vinifera* type. Subject to the same restrictions, any vegetables may be imported from any country under permit and on compliance with these regulations, at such ports as shall be authorized in the permits, on presentation of evidence satisfactory to the United States Department of Agriculture that such vegetables are free from infestation with dangerous insects, including fruit flies (*Trypetidae*), and that their importation will not be the means of bringing such pests to the United States.

In addition, the following exceptions are authorized for the countries concerned:

Commonwealth of Australia—States of Victoria, South Australia, and Tasmania. Upon compliance with these regulations and under such additional conditions and safeguards as may be prescribed in the permits, all fruits and vegetables from these three States will be permitted entry at Seattle, Wash., and Portland, Oreg., and at such other ports as may be specified in the permits.

Japan: Upon compliance with the regulations under Quarantine No. 28, oranges of the mandarin class, including satsuma and tangerine varieties, may be imported from Japan through the port of Seattle and such other northern ports as may be certified in the permits.

Mexico and Central America: Avocados or alligator pears may be imported from Mexico and Central America upon compliance with the restrictions of the order of 27th February 1914. Irish potatoes may be imported from Mexico upon compliance with the regulations of the order of 22nd December 1913.

Chile and Argentina: Upon compliance with these regulations fruits and vegetables, other than those already exempted in the first paragraph of the compendium above, may be imported from Chile and Argentina under such conditions and through such northern ports as designated in the permits.

West Indies: Upon compliance with these regulations all citrus fruits from the West Indies may be permitted entry at New York and at such other ports as designated in the permits.

Jamaica: Entry of pineapples from Jamaica is restricted to the port of New York or such other northern ports as specified in the permits.

Canada: Fruits and vegetables grown in the Dominion of Canada may be imported from Canada free of any restrictions under these regulations.

Application for permits to import fruits or vegetables authorized in these regulations is to be made to the Federal Horticultural Board in advance of the proposed shipments, stating the country or locality of origin of the produce, the port of first arrival, and the name and address of the importer in the United States to whom the permit should be sent. If through no fault of the importer a shipment should arrive before the permit is received, the goods will be held in customs custody at the port of first arrival, at the risk and expense of the importer, for a period not exceeding 20 days. A separate permit must be obtained for shipments from each country and for each port of first arrival in the United States.

The permits of importation are issued in quadruplicate, one copy of which is supplied to the applicant for presentation to the customs officer at the port of first arrival.

All importations of fruits or vegetables are subject as a condition of entry, to such inspection or disinfection, or both, at the port of the first arrival as shall be required by the inspector of the Department of Agriculture and shall be subject to re-inspection at destination at the option of that Department. Should any shipment be found so infected with fruit flies or other dangerous pests that in the judgment of the inspector of the Department of Agriculture it cannot be cleaned by disinfection or treatment, or to contain leaves, twigs, or other portions of plants as packing or otherwise, the whole shipment may be refused entry. All charges for storage, cartage, and labour incident to inspection and disinfection other than the services of the inspector, shall be paid by the importer.

Wart Disease of Potatoes Order of 1923.—*Journ. Min. Agric.*, xxx, 4, pp. 363–366, 1923.

The main features of the Wart Disease of Potatoes Order of 1923, which revokes all previously existing Orders on the subject, may be summarized as follows. The appearance of the disease on any land in England and Wales must immediately be reported to the Ministry of Agriculture. Potatoes visibly affected with wart disease [*Synchytrium endobioticum*] must not be offered for sale. The only potatoes allowed to be planted on land known to have been infected at any time by wart disease are those stocks of approved immune varieties which have been inspected while growing and officially certified as true to type.

The following areas are declared by the Order to be infected. The whole of Wales, the counties of Monmouth, Cheshire, and Staffordshire, the county of Lancashire south of the Ribble, together with Preston and Fulwood, North Salop, Birmingham, and Sutton Coldfield, and certain parishes in the counties of Worcester and Derby. No potatoes grown in an infected area may be removed or consigned to any place in England and Wales which is not in an infected area. This does not apply to 'ware' potatoes of approved immune varieties. All potatoes planted or sold for planting must be officially certified either as having been grown on land free from wart disease, or as having been inspected and found to be free from the disease, or as being of an approved immune variety true to type. When potatoes are sold for planting the seller must furnish the buyer with the number of the relative certificate. Potatoes grown outside Great Britain and Ireland must not be sold for planting in England and Wales except under a licence from the Ministry. The arrangements in connexion with the issue of certificates are explained (a charge of 2*s.* 6*d.* per acre being made when an inspection is required), and the restrictions governing the sale of Scotch and Irish 'ware' potatoes enumerated.

An Act to regulate the sale of Insecticides, Fungicides, Vermin Destroyers, and Weed Destroyers; and for other purposes. Queensland, 20th August, 1923.

Under the present Act any person in Queensland manufacturing

or dealing in insecticides, fungicides, vermin or weed destroyers (called in brief in the Act 'Pest destroyers') must, within 30 days of the passing of this Act or of setting up in such trade, whichever is the later date, and thereafter in each following year on or before the 31st January, give notice in writing in the prescribed form to the Under Secretary of the Department of Agriculture and Stock in Brisbane, of his name and place of business, the distinctive name of every pest destroyer he then sells or proposes to sell during the current year, and the places where the same can be purchased from him. Additional notice is also required to be given of each new pest destroyer or of any alteration in the constituents of those already registered, before commencing to deal in such new or altered pest destroyers.

Every notice is to be accompanied by: the fees prescribed (5s. for each pest destroyer to be registered and 2s. 6d. for each of those already registered for the current year, the constituents of which are altered as above); a fair average sample for analysis of each pest destroyer mentioned; a statutory declaration by the dealer stating the distinctive name of each pest destroyer, that each sample is a fair average sample of the pest destroyer it represents and is not substantially different from the pest destroyer which the dealer will supply throughout the year under its distinctive name, the constituents of each pest destroyer, the constituents thereof which are claimed to be active constituents, the percentage in which each constituent is contained therein and what percentage of each constituent is contained in that part of the pest destroyer which is soluble in cold water, the net weight which shall be contained in each respective package when sold; a specimen copy of the invoice relating to each such pest destroyer; and a specimen copy of the prescribed label to be affixed to each package. Each such label is to show: the distinctive name of the pest destroyer; the net weight contained in the package; a statement of the active constituents; all directions, if any, for the use of the pest destroyer; the name and address of the wholesale dealer; and such other matters as may be prescribed.

A label as prescribed above is to be affixed, on or before delivery to the buyer, on each package of pest destroyer. Every dealer who sells any pest destroyer of a greater value than 5s. must also sign and give to the buyer an invoice showing: the name and address of the dealer; the net weight of the pest destroyer supplied, with the name thereof; a warranty, the wording of which is given, that the constituents of the pest destroyer so sold, and the percentage in which each constituent is contained therein and in that part thereof which is soluble in cold water, accurately correspond with the constituents and percentages stated in the statutory declaration supplied as above. Every buyer shall be entitled, on complying with the regulations, to submit a sample of a pest destroyer bought by him to an official analyst for analysis, and to receive a certificate of the results of such analysis.

Other sections of the Act deal with the appointment and duties of inspectors, penalties, and other details regarding the administration of the Act.

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GENERAL INDEX

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